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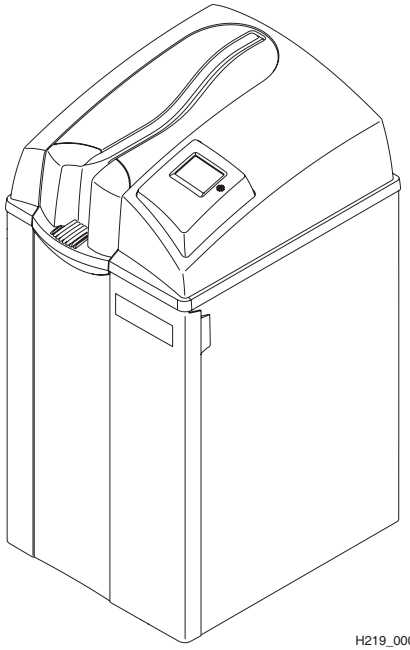
Restricted

THEORY GUIDE
for the
Kodak DirectView CLASSIC/ELITE CR SYSTEM
Service Codes: 5258, 5259

Important

- Qualified service personnel must repair this equipment.
- When performing the procedures outlined in this document, personnel must always employ safe work practices and wear the appropriate personal protective equipment (e.g., safety eyewear) in accordance with Company Standard Operating Procedures.



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This equipment includes parts and assemblies sensitive to damage from electrostatic discharge. Use caution to prevent damage during all service procedures.

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Section 1: Equipment Description

Features and Functions

The *Kodak DirectView* CLASSIC/ELITE CR SYSTEM is a LASER SCANNER that reads a latent image made on a STORAGE PHOSPHOR SCREEN during an X-ray exam and provides a digital image. Physicians and radiologists can then view, improve, store and make a print of the image, and send the image across a computer network.

Feature	Function
SCANNER for the CLASSIC or ELITE CR SYSTEM	• **Size:** 43.8 x 60.3 cm (19.0 x 23.75 in.) • single CASSETTE load with integrated LOCAL USER INTERFACE • uses *DirectView* CR CASSETTES • ELITE CR SYSTEM provides maximum CASSETTE throughput capability • CLASSIC CR SYSTEM provides throughput of approximately 25 - 30% lower than the ELITE CR SYSTEM
BAR CODE READERS	• EXTERNAL BAR CODE READER: – hand-held READER – used to scan the BAR CODE LABEL on CASSETTES and other bar codes used for entering data • INTERNAL BAR CODE READER: – automatically scans the BAR CODE LABEL on CASSETTES that are loaded – provides information about the size, speed, and serial number of the CASSETTE

Feature	Function
WORKFLOW and IMAGE VIEWING CONSOLE (WAIV)	MONITOR - options: • 17 in. FLAT PANEL DISPLAY without TOUCH SCREEN - requires use of KEYBOARD • 19 in. FLAT PANEL DISPLAY with TOUCH SCREEN • allows the operator to touch or click areas displayed on the screen to: – enter exam and patient information – view and improve images • allows the FE to do service diagnostics EXTERNAL PC: • includes software for: – acquiring images from the CLASSIC/ELITE CR SYSTEM – processing images – providing communication with external devices and the computer network • available at all times to the FE
Software Options Available	• new EVP Plus Software • Administrative Analysis and Reporting • Total Quality Tool • Mammography Option - outside US and Canada • Software Refresh
Furniture Options Available	• FLOOR STAND • WALL STAND • either holds MONITOR, KEYBOARD, MOUSE, and BAR CODE READER • FLOOR STAND also holds 10 CASSETTES

Feature	Function
Kodak DirectView REMOTE OPERATIONS PANEL (ROP)	A device that is installed on the wall in an area separate from the CLASSIC/ELITE CR SYSTEM, used for viewing images and entering data. The ROP includes: • computer running *Microsoft Windows* XP • TOUCH SCREEN MONITOR - SVGA device with a 1024 x 768 pixel resolution • EXTERNAL BAR CODE READER - can read all formats identified for the hand-held BAR CODE READER on the CLASSIC/ELITE CR SYSTEM The ROP allows operators to: • enter patient, exam, and CASSETTE (PEC) data into a CLASSIC/ELITE CR SYSTEM • check patient data • view scanned X-ray images • send images to other nodes on the network The PEC data entered through an ROP and sent across the network is associated with the correct image.

Feature	Function
Configurations	• STANDALONE - the CLASSIC/ELITE CR SYSTEM is not connected for use with other CR SYSTEMS on a network: – CLASSIC/ELITE CR SYSTEM supports use with a maximum of 10 REMOTE DEVICES – network connects to WORKSTATIONS for viewing, or reading the images, and to PRINTERS to obtain hardcopy output • CAPTURE LINK SYSTEM - uses a CAPTURE LINK SERVER to support shared use of 2 - 5 CR SYSTEMS on a network • SIMPLE CAPTURE LINK - software option allows shared use of 2 CR SYSTEMS on a network without using a CAPTURE LINK SERVER • In a SIMPLE or CAPTURE LINK SYSTEM: – CR SYSTEMS configured can be *Kodak DirectView* CR 825/850/950/975 SYSTEMS or CLASSIC/ELITE CR SYSTEMS – up to 20 remote devices can be configured for use – workflow is distributed by allowing patient data, CASSETTE ID information, CASSETTE scanning, and image review functions to be shared between CR SYSTEMS and remote devices – CR SYSTEMS and remote devices can only share information and function together within the same SIMPLE or CAPTURE LINK SYSTEM – CR SYSTEMS network connect to WORKSTATIONS for viewing or reading the images and/or to PRINTERS to obtain hardcopy output Remote devices include: • REMOTE OPERATION PANELS (ROP) • Customer provided PC using REMOTE ACCESS SOFTWARE (RAS) allows the PC to be used: – as a REMOTE PATIENT DATA ENTRY STATION (RPDES) – for performing REMOTE KEY OPERATOR functions.

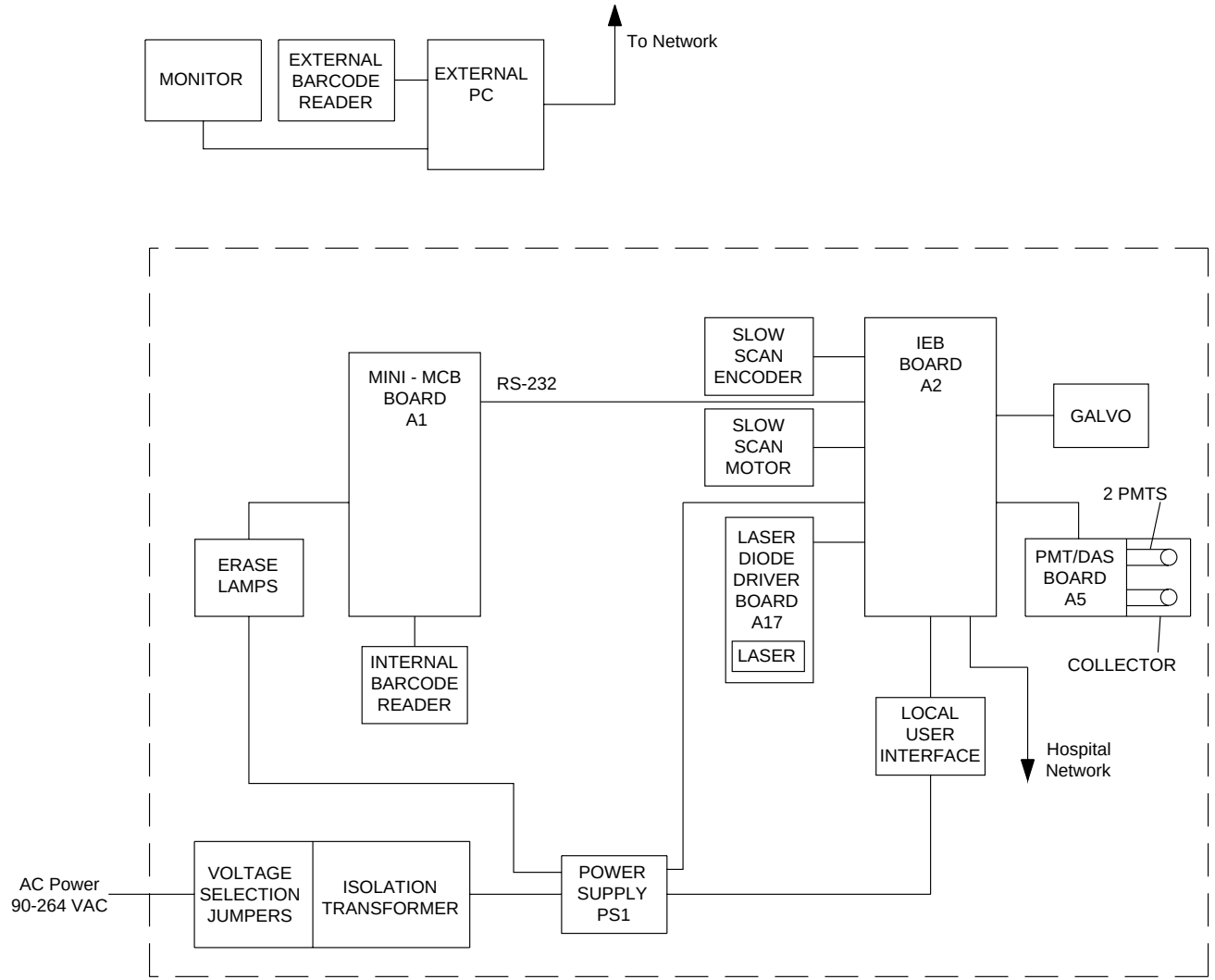
Feature	Function
Network Communications	All CLASSIC/ELITE CR SYSTEMS and ROP devices: • connect to the 10 Base-T, 100 Base-T, or 1000 Base-T *Ethernet* network of the site • can send information to all networked DICOM digital imaging equipment that is qualified with the CLASSIC/ELITE CR SYSTEM • use CATEGORY 5 CABLES to connect to the network • use a gateway device qualified by Carestream Health to enable access to the HIS/RIS system. The customer must provide this device
On-site Service	• CASTERS allow the CLASSIC/ELITE CR SYSTEM to be moved for service without leveling • DATA PLATES and MODIFICATION LABELS are located for easy access and viewing • PLUGS and CONNECTORS are identified • data in the Error and Activity logs can be sorted by field for troubleshooting, for example, by date and error code number • FEs can view internal diagnostics, including error codes, component tests, and tests of the SENSORS from the MONITOR

Feature	Function
Remote Service	• remote access options: – dedicated MODEM connected to the CLASSIC/ELITE CR SYSTEM – MODEM SERVER provided by the customer • one point of access to the service functions of all CLASSIC/ELITE CR SYSTEMS on the customer network from the remote service access connection • access to all service functions, except running the SCAN/ERASE subsystem • remote service: – installing software – setting up the configuration for the CLASSIC/ELITE CR SYSTEM – retrieving and clearing Error and Activity Logs – retrieving Image Processing Library (IPL) diagnostic images **Note** FEs providing remote service cannot view the information about the patient on images.

The following table describes the specifications for the number of CASSETTES per hour:

	CLASSIC CR SYSTEM		ELITE CR SYSTEM	
Size	**High Speed and Reduced Border Scan Mode**	**Standard Speed**	**High Speed and Reduced Border Scan Mode**	**Standard Speed**
24 x 18 GP	77	77	100	100
24 x 30 GP	58	58	76	76
24 x 18 HR	77	77	101	101
24 x 30 HR	58	58	76	76
24 x 18 EHR-M	60	60	79	79
24 x 18 EHR-M2	60	60	79	79
24 x 30 EHR-M	45	45	58	58
24 x 30 EHR-M2	45	45	58	58
30 x 15 GP	92	92	122	122
35 x 35 GP	77	53	102	71
35 x 43 GP	69	46	90	61
35 x 35 GP+	53	53	70	70
35 x 43 GP+	46	46	61	61
35 x 43 LONG-LENGTH CASSETTE	66	66	87	87
35 x 84 GP LLI	68	68	88	88
Tolerance is ± 5				

Main Subsystems



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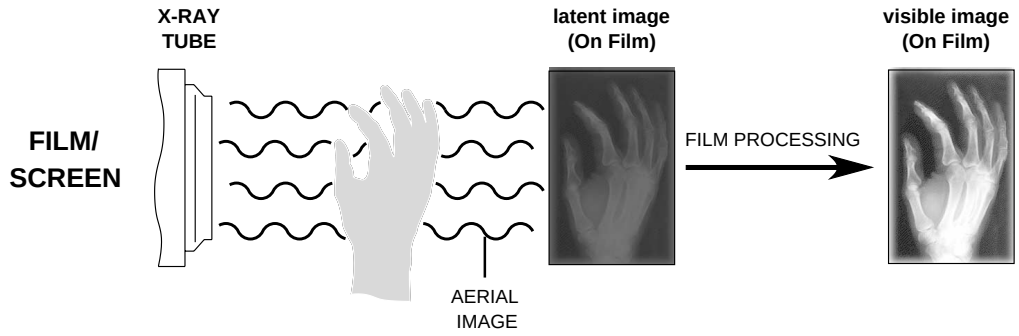
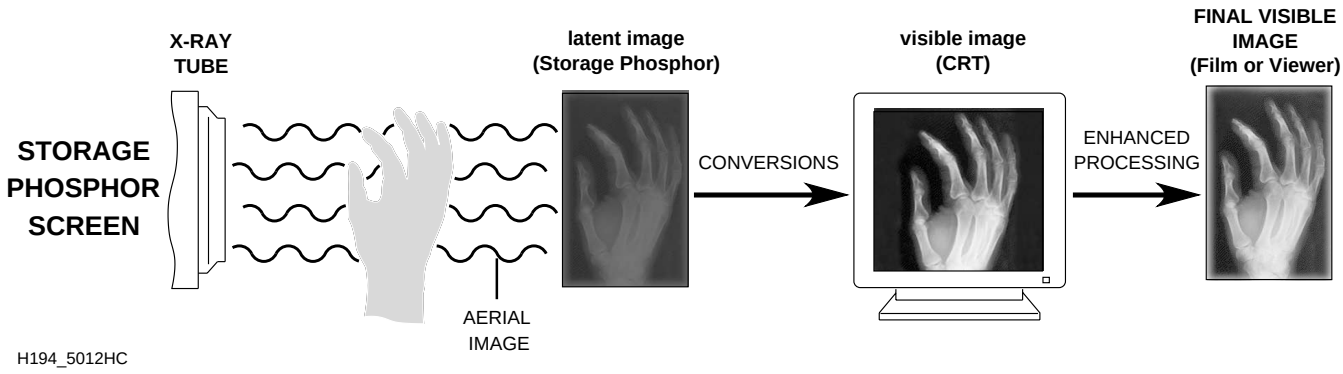
Subsystem	Description	See:
CASSETTE	• includes: – STORAGE PHOSPHOR SCREEN that captures and stores the X-ray image for processing – CASSETTE SHELL that holds the PLATE • available in 5 sizes and 3 resolutions (GP, HR, and EHR)	**STORAGE PHOSPHOR CASSETTE**
CASSETTE HANDLING	• allows the operator to load the CASSETTE into the CLASSIC/ELITE CR SYSTEM • removes the PLATE from the CASSETTE SHELL • after scanning, installs the PLATE in the CASSETTE SHELL • allows the CASSETTE to be removed from the CLASSIC/ELITE CR SYSTEM	**CASSETTE HANDLING**
Optical	• controls and moves the laser beam to the SCREEN • captures the blue light emitted from the SCREEN	**Optical**
Scan/Erase	• moves the PLATE at a uniform speed: – through the scanning area – to the erase position • removes the residual image on the SCREEN by exposing it to maximum light • inserts the PLATE into the CASSETTE SHELL again	**Scan/Erase**
Imaging	• assembles the data from the SCREEN and changes it to digital format • processes the image	**Imaging Sequence**

Subsystem	Description	See:
Logic and Control	• processes commands from the operator • controls the operation of all subsystems • sends processed images to the network for distribution	Logic and Control
Power Distribution	• provides power for all subsystems • has an INTERLOCK SWITCH that actuates when the FRONT COVER is removed	Power Distribution
Error and Activity Logs	• records logs of errors in the system • records user actions	Logs

Section 2: Radiography Theory

Comparison of Film/Screen and Computed Radiography (CR)





X-rays are used in medical imaging to make an image of given body parts on a surface, which can be read by a Radiologist or other medical personnel. The available systems for capturing these images are:

- Screen/film - captures a projection image on an X-ray film
- Computed Radiography (CR) - captures a digital image

The following phases are necessary to capture and process projection radiographs for both screen/film systems and CR systems:

Phase of Image Capture	Description
P**hase 1** - Making the aerial image	In both screen/film and CR SYSTEMS: • an X-ray TUBE emits X-rays in the direction of an IMAGE RECEPTOR • when the X-rays reach the body of the patient, some are absorbed by the patient and some are not. The result is an “aerial” image with varying degrees of X-ray power (varying numbers of X-ray PHOTONS)
Phase 2 - Capturing the latent image	When the IMAGE RECEPTOR is exposed to the X-rays in the aerial image, a latent image is captured on the RECEPTOR: • screen/film systems - image is captured on sensitized radiographic film • CR SYSTEMS - image is captured on a STORAGE PHOSPHOR SCREEN. The X-ray PHOTONS that reach the SCREEN charge the PHOSPHOR, making a latent image on the screen
Phase 3 - Capturing, changing, and storing the visible image	The latent image must be changed to a visible image, which can be read by the Radiologist, moved from one place to another, and stored for use at another time: • screen/film systems - radiographic film is processed through chemicals and the latent image is fixed onto the film • CR SYSTEMS - the latent image on the STORAGE PHOSPHOR SCREEN is scanned by a laser beam, which stimulates the charged PHOSPHOR on the SCREEN. Blue light is emitted from the stimulated PHOSPHOR, assembled, and changed into analog electrical signals. The analog image is then changed into digital signals and processed. The digital image is stored and displayed by a computer system and can be routed to other computers and PRINTERS through a network

The following table compares the analog and digital health image capture systems.

Analog Screen/Film Systems	Digital CR Systems
Uses “Rare Earth” SCREENS - GADOLINIUM OXYSULFIDE or LANTHANUM OXYBROMIDE.	Uses a BARIUM FLOUROHALIDE STORAGE PHOSPHOR SCREEN.
Speed range from 100 - 1000.	Phosphor SCREEN types. Use: • General Purpose (GP) for most general radiography exams • High Resolution (HR) for general radiography extremity exams • Enhanced High Resolution (EHR) for mammography exams
Film processing parameters are important in determining the quality of the image, for example: chemical temperature and timing.	No film processing is necessary.
It is hard to obtain the same print quality when copies are necessary because of variations in GENERATORS, PROCESSORS, positions, procedures, and conditions for developing the film.	The user can print a copy of the digital image at any time with a consistent level of quality.
Overexposing or underexposing an image normally makes it necessary to expose the patient to ionizing radiation again.	Exposure factors do not normally make it necessary to expose the patient to ionizing radiation again.
Image quality is changed by conditions in the environment, for example temperature or humidity.	Image quality is not changed by conditions in the environment.
The image cannot be viewed in more than one place at a time.	CR images can be viewed at more than one place at the same time, in the same building or in remote nodes on the network.

Analog Screen/Film Systems	Digital CR Systems
• Recording medium - film • Output medium - film • Storing medium - film	• Recording medium - STORAGE PHOSPHOR SCREEN • Output medium - film, paper, digital display • Storing medium - digital
Image density and contrast are controlled by kilovolts peak (kvP), milliampere seconds (mA.s), and film type.	Density and contrast are controlled by image processing parameters. kvP, and mA.s continue to be important image control factors for details and noise in the digital image.
Viewing quality can only be improved by increasing the brightness of the LAMP that illuminates the film.	Digital images can be improved by processing on a computer to change the density, contrast, sharpness, and other factors.
The quality of films that are not exposed correctly cannot be improved.	Images that were not exposed correctly can be improved. For example, software parameters can improve image density and contrast.

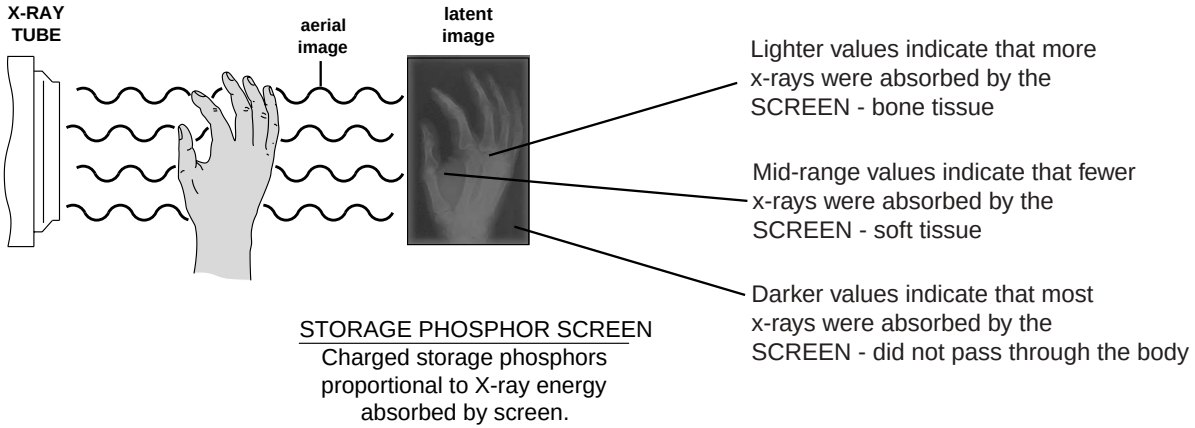
Overview of CR Technology

Operations

The following operations are necessary to capture the latent image in the STORAGE PHOSPHOR SCREEN and change it to a digital image that can be viewed on a computer screen and sent to a PRINTER.

- **Exposing the STORAGE PHOSPHOR SCREEN**
- **Stimulating the PHOSPHOR**
- **Changing Light Energy to an Analog Signal**
- **Changing Analog Signals to Digital Signals**
- **Processing the Digital Image**

Exposing the STORAGE PHOSPHOR SCREEN


X-RAY TUBE
aerial image
latent image
Lighter values indicate that more x-rays were absorbed by the SCREEN - bone tissue
Mid-range values indicate that fewer x-rays were absorbed by the SCREEN - soft tissue
Darker values indicate that most x-rays were absorbed by the SCREEN - did not pass through the body
STORAGE PHOSPHOR SCREEN
Charged storage phosphors proportional to X-ray energy absorbed by screen.

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When a STORAGE PHOSPHOR SCREEN is exposed to X-rays:

- special PHOSPHOR on the SCREEN absorbs the radiation in degrees of intensity determined by the body part and the type of SCREEN:
  - soft body tissues absorb a small quantity of radiation - these areas are indicated in the X-ray image by mid-range values
  - bone tissues absorb most of the radiation - these areas are indicated in the X-ray image by light values
  - X-rays that do not hit any obstructions are indicated in the X-ray image by dark values
  - High Resolution SCREENS absorb less energy than General Purpose SCREENS
- SCREEN has a latent image in the areas that were exposed to the radiation. The quantity of stored energy or charge on the SCREEN is proportional to the quantity of X-ray energy absorbed by the SCREEN.

Characteristics of the STORAGE PHOSPHOR SCREEN	Description
X-ray absorption	About 50% of the X-ray energy is released in the form of fluorescence when the SCREEN is exposed. The X-ray energy remaining makes the latent image on the SCREEN.
Photostimulable luminescence	When the charged PHOSPHOR on the SCREEN is stimulated by light, the PHOSPHOR releases or discharges blue light proportional to the energy the PHOSPHOR has stored.
Fading	The latent image fades with time, but it is possible to read data from the SCREEN for a number of days after scanning.
Residual image	After a SCREEN is erased by exposing it to light, it keeps some charge from the latent image. This charge does not make the SCREEN less effective when it is used again.

Characteristics of the STORAGE PHOSPHOR SCREEN	Description
Signal accumulation	Signals can accumulate on SCREENS that are not used for more than 24 hours. Erasing these SCREENS decreases the residual image to the optimum range for using the SCREEN again. Failure to erase these signals can result in artifacts.
Long life	The photostimulable luminescent quality of the SCREEN does not decrease with time. The life of a SCREEN can be decreased by damage to the material.

Stimulating the PHOSPHOR

It is necessary to stimulate the PHOSPHOR in the SCREEN to read the latent image. The following components of the CR SYSTEMS provide this function:

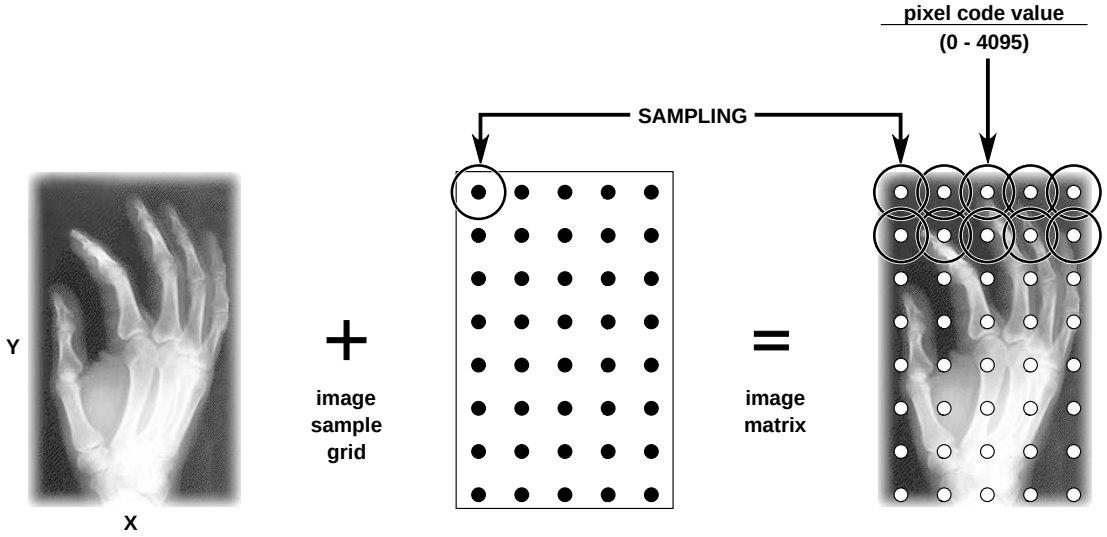
- light source:
  - exposes the SCREEN with high-intensity light that stimulates the ELECTRONS and causes the ELECTRONS to be luminescent
  - laser beam moves from one side of the SCREEN to the other to expose the image
- GALVO MIRROR:
  - moves the laser beam across the SCREEN and then back to the start position. At the same time, the SCREEN moves perpendicular to the scanning direction of the laser beam
  - is continually monitored and adjusted to check that the scanning operation is correct and has a continual speed
- scanning optics:
  - focuses and shapes the laser beam, keeping the speed and angle of the beam the same when it moves across the SCREEN
  - angle of a laser beam determines the size, shape, and speed of the beam. An example is the beam of a FLASHLIGHT moving across a flat surface from one edge to the center and to the other edge

Changing Light Energy to an Analog Signal

The following components of CR SYSTEMS change the light energy in the exposed SCREEN to an analog signal:

- LIGHT COLLECTOR:
  - provides the collection of the blue light emitted when the SCREEN is stimulated by the laser beam
  - CLASSIC/ELITE CR SYSTEM uses an INTEGRATING CAVITY with MIRRORS to provide the collection of the blue light
- BLUE FILTER:
  - does not allow any red light reflected from the SCREEN to reach the LIGHT DETECTORS
  - allows only the blue light to reach the LIGHT DETECTORS
- LIGHT DETECTORS:
  - are normally PHOTOMULTIPLIER TUBES (PMT)
  - receive light that enters the COLLECTOR
  - change the light PHOTONS into ELECTRONS when the PHOTONS enter through a PHOTOCATHODE. When the ELECTRONS move through the LIGHT DETECTORS, the ELECTRONS increase in number - “gain”
  - when more than one LIGHT DETECTOR is used in a system, the system adds and changes the signals into one output. The output from the added PMTs can include frequencies that are outside of the limits of the system - “noise”. An ANALOG FILTER limits this noise

Changing Analog Signals to Digital Signals



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Analog signals are changed to digital signals by sampling the blue light from the STORAGE PHOSPHOR SCREEN and moving it through an ANALOG-TO-DIGITAL CONVERTER to make a digital value for the brightness of each sample.

Sampling is similar to making a photograph of the signal at a given time. The sample has both a horizontal and a vertical value. The size of the sample is defined in the system software for both the horizontal and vertical directions.

- The horizontal value indicates a point in time in the motion of the laser beam across the SCREEN.
- The vertical value indicates a line on the screen at a right angle to the scanning direction.

If you locate both the horizontal and the vertical points of the sample on an imaginary matrix, similar to the one in the graphic, the result indicates one pixel in the digital image.

Continual analog input values are changed to output values. In this process, the replacement of small ranges of analog input values with one digital output value occurs. The digital output value indicates one pixel of information on the MONITOR.

The output is a linear digital signal. The CLASSIC/ELITE CR SYSTEM emits a 16-bit digital signal with a total signal range of 65,536 levels. Because it is not possible for the human eye to see this range of separate values, the CLASSIC/ELITE CR SYSTEM changes the 16-bit linear image data to 12-bit log data. This 12-bit log provides data from 0 - 4095 values. These values are used in the CLASSIC/ELITE CR SYSTEM.

Processing the Digital Image

Digital imaging allows users to improve diagnostic images by processing the images. After the digital image is made, the digital data is processed using parameters set up in the software. In the CLASSIC/ELITE CR SYSTEM, this processing occurs in the EXTERNAL PC.

Examples of image processing used for digital images:

- segmentation
- tone scaling
- edge enhancement
- brightness - level
- contrast - window

Section 3: Sequence of Operation

Overview of Workflow Using the CLASSIC/ELITE CR SYSTEM

1 The Radiology Department receives an exam request.

2 The Radiology Technologist (RT) assembles the patient information. Examples of patient information are patient name, ID, and accession number.

Note

On the CLASSIC/ELITE CR SYSTEM, you can receive patient information through a DICOM-MODALITY WORKLIST PROVIDER.

3 The operator can select network nodes to send the image data.

4 The operator uses a CR CASSETTE to do the exam, capturing the latent image on the STORAGE PHOSPHOR SCREEN.

5 Using the CLASSIC/ELITE CR SYSTEM or the ROP, the operator enters the CASSETTE ID Information by scanning the CASSETTE BAR CODE or entering it manually.

6 The operator inserts the exposed CASSETTE into the CLASSIC/ELITE CR SYSTEM. The system scans the SCREEN, capturing the latent image on the SCREEN and changing it to a digital image. After scanning, the SCREEN is automatically erased and inserted into the CASSETTE SHELL.

7 The CLASSIC/ELITE CR SYSTEM processes the image. If the system is in:

- “Pass-Through Mode” - the image is automatically sent to all network nodes
- “QA Mode” - the operator can process the image and then send it to other network nodes

8 If necessary, the image can be processed and sent to network nodes again.

Before Loading the CASSETTE

1 After initializing, the CLASSIC/ELITE CR SYSTEM is ready to receive a CASSETTE for scanning. The LOCAL USER INTERFACE (LUI) displays:

- Status ICON: green
- name of the system in white text

2 The RT uses a CR CASSETTE to capture the latent image of the body part on the SCREEN.

Status Summary: Ready to Receive a CASSETTE
• CLAMP BAR is in the open position
• PIVOTING PLUSH is in the open position
• LIGHT SEAL BAR is in the open position
• EXTRACTION BAR is at the home position
• HOOKS are in the down position

Loading the CASSETTE

1 The RT loads the CASSETTE into the INPUT SLOT until the CASSETTE reaches the CASSETTE ENTRY SENSOR S3.

2 The CASSETTE ENTRY SENSOR S3 detects the CASSETTE, and the SLOW SCAN MOTOR moves up to lock the TOP CAP of the EXTRACTION BAR.

3 When the CASSETTE is inserted, the INTERNAL BAR CODE READER reads the size, speed, and serial number of the CASSETTE, then:

- emits a sound
- sends information to the IEB BOARD A2:
  - “CASSETTE Detected” message
  - size of the CASSETTE

4 When the CASSETTE reaches the CASSETTE EXTRACTION SENSOR S4, the CLAMP MOTOR closes the CLAMP BAR until the CLAMP CLOSED SENSOR S2 is blocked.

Note

If the INTERNAL BAR CODE READER did not read the bar code correctly, the operator must enter the data manually at the LUI. The CLAMP MOTOR will not close the CLAMP until the operator enters the size of the CASSETTE.

5 The MINI-MCB BOARD A1 sends “CASSETTE Detected” message to the IEB BOARD A2.

6 The IEB BOARD A2 sends a “Scan Request” message to the EXTERNAL PC.

7 The EXTERNAL PC:

- checks that it has the quantity of memory necessary to receive an image
- makes a raw image file to receive the image
- sends a “Scan Request Reply” message to the IEB BOARD A2 with a value of “OK”

8 The IEB BOARD A2 receives the information about the size and speed of the CASSETTE.

Status Summary: CASSETTE Loaded
• SLOW SCAN is in the up position
• TOP CAP on the EXTRACTION BAR is locked
• CLAMP BAR is closed
• PLATE remains inside the CASSETTE
• HOOKS on the EXTRACTION BAR are not extended
• bar code was read

Removing the PLATE from the CASSETTE

1. The IEB BOARD A2 sends a message to the MINI-MCB BOARD A1 to load the PLATE.
2. The SLOW SCAN MOTOR moves down to unlock the TOP CAP, and the HOOKS MOTOR moves to the “HOOKS in Lane” position.
3. The SLOW SCAN MOTOR moves the HOOKS up into the CASSETTE.
4. The HOOKS MOTOR moves the HOOKS to the “Unlatch” position.
5. The PLATE is “Unlatched” from the CASSETTE, and the SLOW SCAN MOTOR moves the PLATE to the “Start of Scan” position.
6. The MINI-MCB BOARD A1 sends a message to the IEB BOARD A2 that the PLATE is loaded.

Note

If any MOTOR does not move correctly, the MINI-MCB BOARD A1 sends an error message to the IEB BOARD A2.

Status Summary: PLATE Fastened
• CLAMP BARS are holding the CASSETTE
• PLATE is fastened to the EXTRACTION BAR
• EXTRACTION BAR is at the “Start of Scan” position with the fastened PLATE
• PIVOTING PLUSH has made a light-tight environment around the CASSETTE

Scanning the SCREEN

1 The IEB BOARD A2:

- actuates the GALVO
- sends a signal to the MINI-MCB BOARD A1 to start the scan, which starts the SLOW SCAN MOTOR
- sends a signal to the EXTERNAL PC that the scan is starting

2 The EXTERNAL PC displays a PROGRESS BAR on the Scan Status screen. This is a graphic display only and not a real-time indication of the status of the scanning operation. The LUI also displays a PROGRESS BAR for the scan status.

3 The SLOW SCAN MOTOR rotates, moving the PLATE at a continual speed through the field of scan in the slow scan direction.

4 The IEB BOARD A2 controls the motion of the laser beam across the SCREEN in the fast scan direction. The SCREEN is scanned one pixel at a time, one line at a time. See **Scanning the SCREEN - Slow Scan/Fast Scan**.

Note

- The fast scan motion is an almost horizontal trace across the SCREEN, from the back of the SCREEN toward the front. When it reaches the end of a line, it does a fast retrace to start another line. During the scanning, the SCREEN is moving down at a controlled speed to make each fast scan trace one pixel line higher up on the SCREEN than the line before. The result is that the fast scan is in a slightly diagonal trace across the SCREEN.
- The slow scan runs for a determined number of lines in the vertical direction. A set number of samplings occur for each line. The number is determined by the size of the SCREEN. Both the number of lines and the number of samplings are set up in the calibration for that size of SCREEN.

5 When the end of the scan is reached, the MINI-MCB BOARD A1 sends a status message to the IEB BOARD A2.

6 The IEB BOARD A2 de-energizes the PMTs, GALVO, and the LASER.

7 The IEB BOARD A2 sends a “Scan End” message to the EXTERNAL PC. The PROGRESS BAR displays until the image is transferred to the EXTERNAL PC.

Erasing the SCREEN

1. The IEB BOARD A2 sends an “Erase Plate” command to the MINI-MCB BOARD A1, which sends a signal to the SLOW SCAN to start the erasing operation.
2. The SLOW SCAN MOTOR actuates and moves the PLATE into the erase position, determined by the counts of the SLOW SCAN ENCODER.
3. The MINI-MCB BOARD A1 energizes the ERASE LAMPS to illuminate for 2 - 16 seconds to remove the image from the SCREEN.

Note

The length of time the ERASE LAMPS illuminate is determined by the highest pixel code value of the image that was scanned. If one pair of LAMPS is not operating, the time increases by a factor of 2. If more than one pair of LAMPS is not operating, a message displays on the MONITOR.

4. When the SCREEN is erased, the MINI-MCB BOARD A1 sends the “Erase Done” status to the IEB BOARD A2.

Inserting the PLATE back into the CASSETTE SHELL

1 The IEB BOARD A2 issues a command to the MINI-MCB BOARD A1 to:

- return the EXTRACTION BAR to the home position
- insert the PLATE into the CASSETTE

2 The MINI-MCB BOARD A1 reverses the SLOW SCAN MOTOR, which moves the PLATE up into the open CASSETTE SHELL.

3 The PLATE POSITIONING AY guides the PLATE into the CASSETTE SHELL from the back side.

4 When the EXTRACTION BAR reaches the home position, the SLOW SCAN MOTOR stops. At the home position, the ENCODER counts are the saved value.

Status Summary: PLATE Inserted Into the CASSETTE
• SLOW SCAN MOTOR is stopped • PLATE is inside the CASSETTE • HOOKS are inside the PLATE

Removing the CASSETTE

1 The IEB BOARD A2 sends an “Eject Cassette” command to the MINI-MCB BOARD A1.

2 The HOOKS MOTOR energizes, and moves the HOOKS to the “Unlatch” position.

3 The CLAMP MOTOR energizes to open the CLAMP BAR until the CLAMP OPEN SENSOR S1 is blocked.

4 A message on the LUI tells the operator to remove the CASSETTE.

5 The MINI-MCB BOARD A1 sends the “Cassette Ejected” status to the IEB BOARD A2.

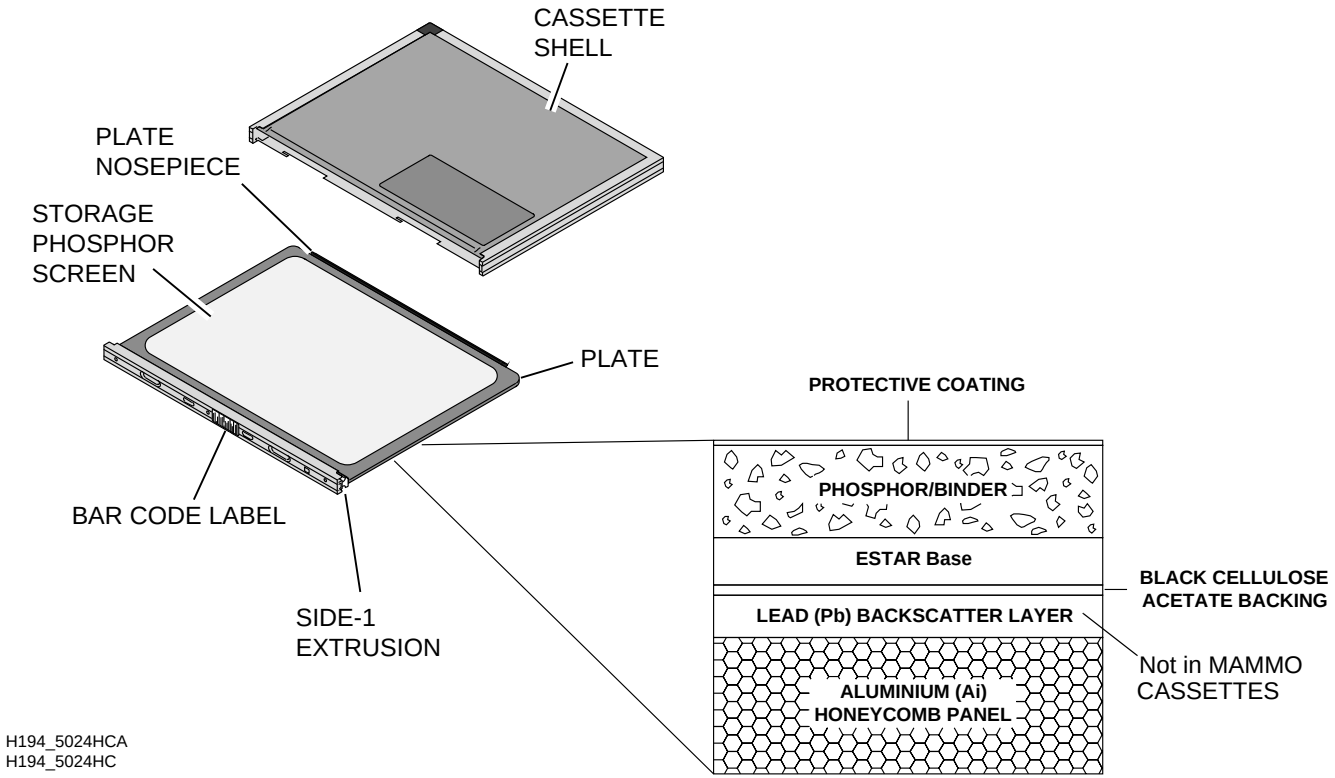
6 After the operator removes the CASSETTE, the MINI-MCB BOARD A1 sends a “Cassette removed” status to the IEB BOARD A2.

Note

The CLASSIC/ELITE CR SYSTEM cannot process another PLATE until the “Cassette Removed” status is received.

Section 4: STORAGE PHOSPHOR CASSETTE

Overview



STORAGE PHOSPHOR CASSETTES have a SCREEN with a layer of PHOSPHOR that is charged by X-ray PHOTONS. STORAGE PHOSPHOR SCREENS can capture a wider range of information within the aerial image than is possible with a screen/film system.

STORAGE PHOSPHOR CASSETTES include:

Component	Description
CASSETTE SHELL	The SHELL has a CARBON FIBER FRONT and an aluminum BACK. The SHELL is open on one side for removal of the PLATE. A LATCH on the inside of the PLATE holds it in place inside the SHELL.
PLATE	Includes: • STORAGE PHOSPHOR SCREEN - made of an ESTAR BASE with a layer of PHOSPHOR PARTICLES suspended in a POLYMER BINDING, a light-absorbing black BACKING, and a LEAD BACKSCATTER LAYER. The PHOSPHOR LAYER has a COATING that extends beyond the edge of the PHOSPHOR to protect the PHOSPHOR from damage. • BACKING - a rigid aluminum “honeycomb” PANEL that makes inserting the SCREEN into the CASSETTE SHELL easier. • 2 hard plastic STRIPS - fastened to the back side of the PLATE to make the thickness of the PLATE the same as the thickness of the PLATE NOSEPIECE. This uniform thickness allows the PLATE GUIDE ROLLERS to move smoothly on the back of the PLATE.
BAR CODE LABEL	Each CASSETTE has a BAR CODE LABEL on the SIDE-1 EXTRUSION. The BAR CODE LABEL identifies the CASSETTE.
SIDE-1 EXTRUSION	The edge of the PLATE with the LATCH. The EXTRACTION BAR HOOKS insert into the LATCH to remove the PLATE from the CASSETTE SHELL.
PLATE NOSEPIECE	Plastic edge on the PLATE that guides the PLATE back into the CASSETTE SHELL.

Size and Resolution of SCREENS

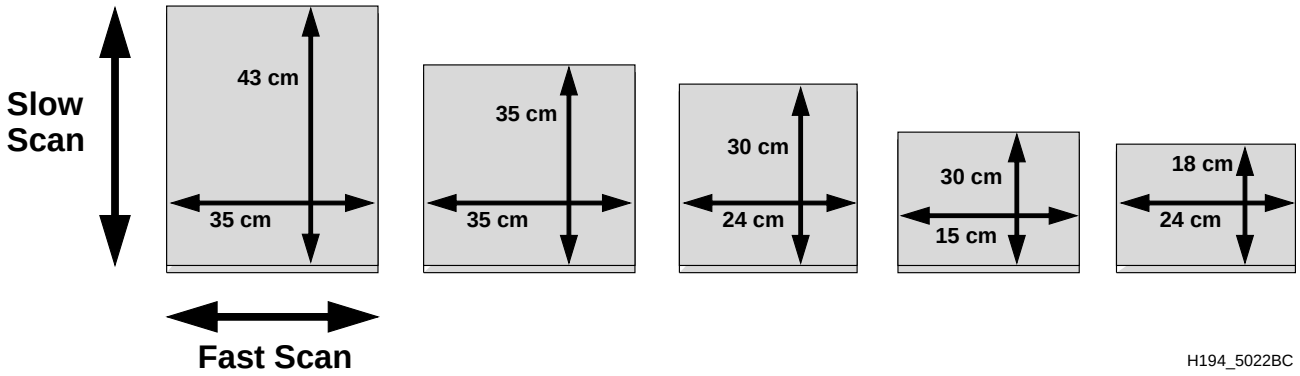
Size of the SCREEN	Resolution			Compatible With:
	GP	HR	EHR	
15 x 30 cm	YES	NO	NO	*Kodak DirectView* CR 800/825/850/900/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS
35 x 43 cm	YES	NO	NO	CR 800/825/850/900/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS
35 x 43 cm - *Kodak DirectView* CR LONG-LENGTH IMAGING SYSTEM	YES	NO	NO	CR 800/825/850/900/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS
35 x 35 cm	YES	NO	NO	CR 400/800/825/850/900/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS
24 x 30 cm	YES	YES	---	CR 400/800/825/850/900/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS
			YES	CR 850/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS
24 x 18 cm	YES	YES	---	CR 400/800/825/850/900/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS
			YES	CR 850/950/975 SYSTEMS and CLASSIC/ELITE CR SYSTEMS

The CLASSIC/ELITE CR SYSTEM uses SCREENS with the following resolutions:

Resolution of the SCREEN	Description
General Purpose (GP)	• thicker PHOSPHOR COATING than the HR SCREEN, making the image less sharp • no special exposure procedures are necessary
High Resolution (HR)	• thinner PHOSPHOR COATING than the GP SCREEN, making the image sharper • approximately 2 times the X-ray exposure is necessary
Enhanced High Resolution (EHR)	• same PHOSPHOR COATING as the HR SCREEN • approximately 2 times the X-ray exposure

The light intensity of the exposed GP SCREEN is less than the HR and EHR SCREENS. The CLASSIC/ELITE CR SYSTEM adjusts for the difference in light intensity by adjusting the pixel code values in the image processing.

Fast Scan / Slow Scan Directions



The diagram indicates the direction of the 2 scanning actions for each size CASSETTE:

- slow scan - the SCREEN moves vertically from up to down during scanning
- fast scan - the laser beam moves horizontally across the SCREEN at the same time it moves down

Problems in the slow scan process can cause artifacts in the image. For example, banding artifacts can appear across the SCREEN in the horizontal direction, but the cause of the artifact might be a problem with the vertical slow scan motion of the SCREEN.

Image Matrix Size

The CLASSIC/ELITE CR SYSTEM scans the STORAGE PHOSPHOR SCREENS at the resolutions in the tables below.

Table 1 Standard Resolution CASSETTES (GP) - High Speed Mode

Size of SCREEN	Image Size Pixels x Lines	Pixel Size in Microns	Spatial Resolution LP = Line Pairs	File Size
30 x 15 cm	2500 x 1250	115 ± 2	4.34 LP/mm	6.3 MB
35 x 43 cm	2048 x 2500	168 ± 2	2.97 LP/mm	10.2 MB
35 x 35 cm	2048 x 2048	168 ± 2	2.97 LP/mm	8.4 MB
24 x 30 cm	2400 x 3020	97 ± 2	5.15 LP/mm	14.5 MB
24 x 18 cm	2392 x 1792	97 ± 2	5.15 LP/mm	8.6 MB
35 x 43 cm LLI	2200 x 2500	168 ± 2	2.97 LP/mm	11.0 MB
35 x 43 cm GP+	3610 x 4400	97 ± 2	5.15 LP/mm	31.8 MB
35 x 35 cm GP+	3610 x 3610	97 ± 2	5.15 LP/mm	26.1 MB
35 x 84 cm LLI	2048 x 2600	168 ± 2	2.97 LP/mm	10.7 MB

Table 2 Standard Resolution CASSETTES (GP) - Standard Speed Mode

Size of SCREEN	Image Size Pixels x Lines	Pixel Size in Microns	Spatial Resolution LP = Line Pairs	File Size
30 x 15 cm	2500 x 1250	115 ± 2	4.34 LP/mm	6.3 MB
35 x 43 cm	3610 x 4400	97 ± 2	5.15 LP/mm	31.8 MB
35 x 35 cm	3610 x 3610	97 ± 2	5.15 LP/mm	26.1 MB
24 x 30 cm	2400 x 3020	97 ± 2	5.15 LP/mm	14.5 MB
24 x 18 cm	2392 x 1792	97 ± 2	5.15 LP/mm	8.6 MB
35 x 43 cm LLI	2200 x 2500	168 ± 2	2.97 LP/mm	11.0 MB
35 x 43 cm GP+	3610 x 4400	97 ± 2	5.15 LP/mm	31.8 MB
35 x 35 cm GP+	3610 x 3610	97 ± 2	5.15 LP/mm	26.1 MB
35 x 84 cm LLI	2048 x 2600	168 ± 2	2.97 LP/mm	10.7 MB

Table 3 Standard Resolution CASSETTES (GP) - Reduced Border Mode

Size of SCREEN	Image Size Pixels x Lines	Pixel Size in Microns	Spatial Resolution LP = Line Pairs	File Size
30 x 15 cm	2500 x 1250	115 ± 2	4.34 LP/mm	6.3 MB
35 x 43 cm	2048 x 2500	171 ± 2	2.97 LP/mm	10.2 MB
35 x 35 cm	2048 x 2048	171 ± 2	2.97 LP/mm	8.4 MB
24 x 30 cm	2400 x 3020	97 ± 2	5.15 LP/mm	14.5 MB
24 x 18 cm	2392 x 1792	97 ± 2	5.15 LP/mm	8.6 MB
35 x 43 cm LLI	2200 x 2500	168 ± 2	2.97 LP/mm	11.0 MB
35 x 43 cm GP+	3610 x 4400	97 ± 2	5.15 LP/mm	31.8 MB
35 x 35 cm GP+	3610 x 3610	97 ± 2	5.15 LP/mm	26.1 MB
35 x 84 cm LLI	2048 x 2600	168 ± 2	2.97 LP/mm	10.7 MB

Table 4 High Resolution CASSETTES (HR)

Size of SCREEN	Image Size Pixels x Lines	Pixel Size in Microns	Spatial Resolution LP = Line Pairs	File Size
24 x 18 cm (HR)	2392 x 1792	97 ± 2	5.15 LP/mm	8.6 MB
24 x 30 cm (HR)	2400 x 3020	97 ± 2	5.15 LP/mm	14.5 MB

Table 5 Enhanced High Resolution CASSETTES (EHR-M and EHR-M2)

Size of SCREEN	Image Size Pixels x Lines	Pixel Size in Microns	Spatial Resolution LP = Line Pairs	File Size
24 x 30 cm (EHR)	6000 x 4800	48.5 ± 2	10.3 LP/mm	54.6 MB
24 x 18 cm (EHR)	4784 x 3584	48.5 ± 2	10.3 LP/mm	34.3 MB

For smaller SCREENS, compared to larger SCREENS:

- pixel size is smaller
- spot size of the laser beam and digitizing rate are the same
- scanning speed is slower. To make smaller pixels, the speed of the horizontal motion of the laser beam will decrease during the fast scan and the transport speed of the SCREEN under the COLLECTOR will decrease during the slow scan. The decrease in pixel size increases the spatial resolution of the image.

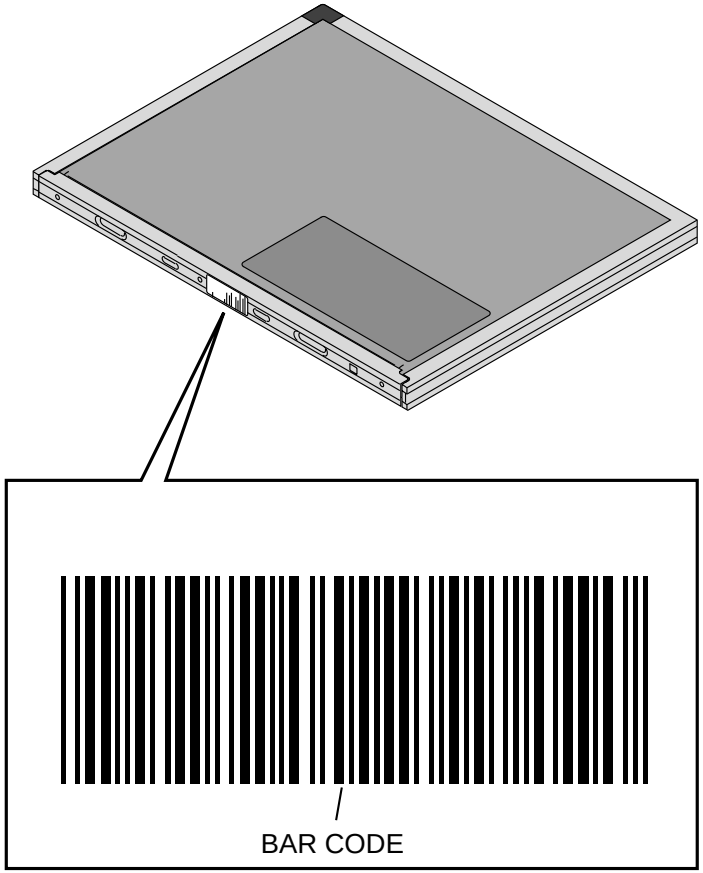
The spatial resolution is determined by the following factors:

- scatter of the PHOSPHOR
- spot size and shape of the laser beam
- bandwidth of the electronics

Note

The image file size for the 24 x 30 cm SCREEN is larger than the image file size for the 35 x 35 cm SCREEN because of the higher sampling rate.

Reading the BAR CODE LABEL of the CASSETTE



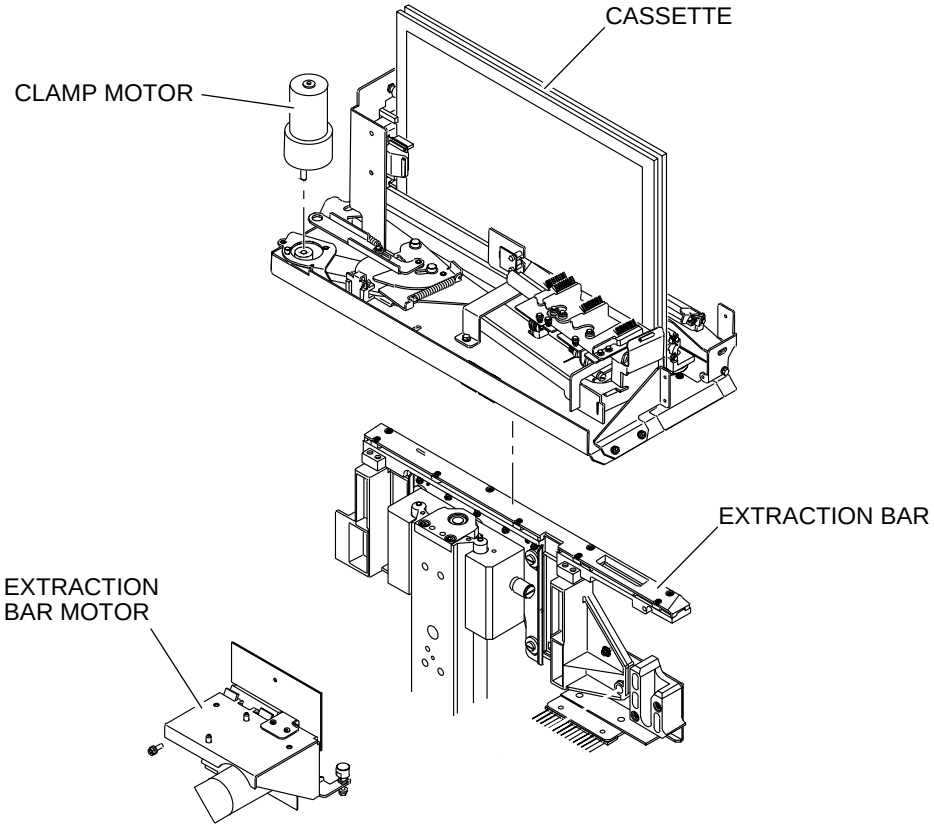
H194_5025GCA
H194_5025GC

The BAR CODE LABEL identifies the CASSETTE and provides the size and resolution of the SCREEN. The following table describes the digits in the BAR CODE. Each digit indicates a group of BARS on the bar code.

Digit	Value
1	Has the value “9”
2	Resolution: 1 = General Purpose (GP) 2 = High Resolution (HR) 3 = Enhanced High Resolution (EHR)
3 - 4	Size: 01 = 24 x 18 cm 02 = 24 x 30 cm 03 = 35 x 35 cm 04 = 35 x 43 cm 05 = 35 x 43 L 06 = 15 x 30 cm 07 = 24 x 30 cm (HR) 08 = 24 x 18 cm (EHR) 09 = 24 x 30 cm (EHR) 10 = 35 x 35 C 11 = 35 x 43 C
5 - 10	Serial number of the CASSETTE

Section 5: CASSETTE HANDLING

Overview



H219_7501HCA
H219_7501HC

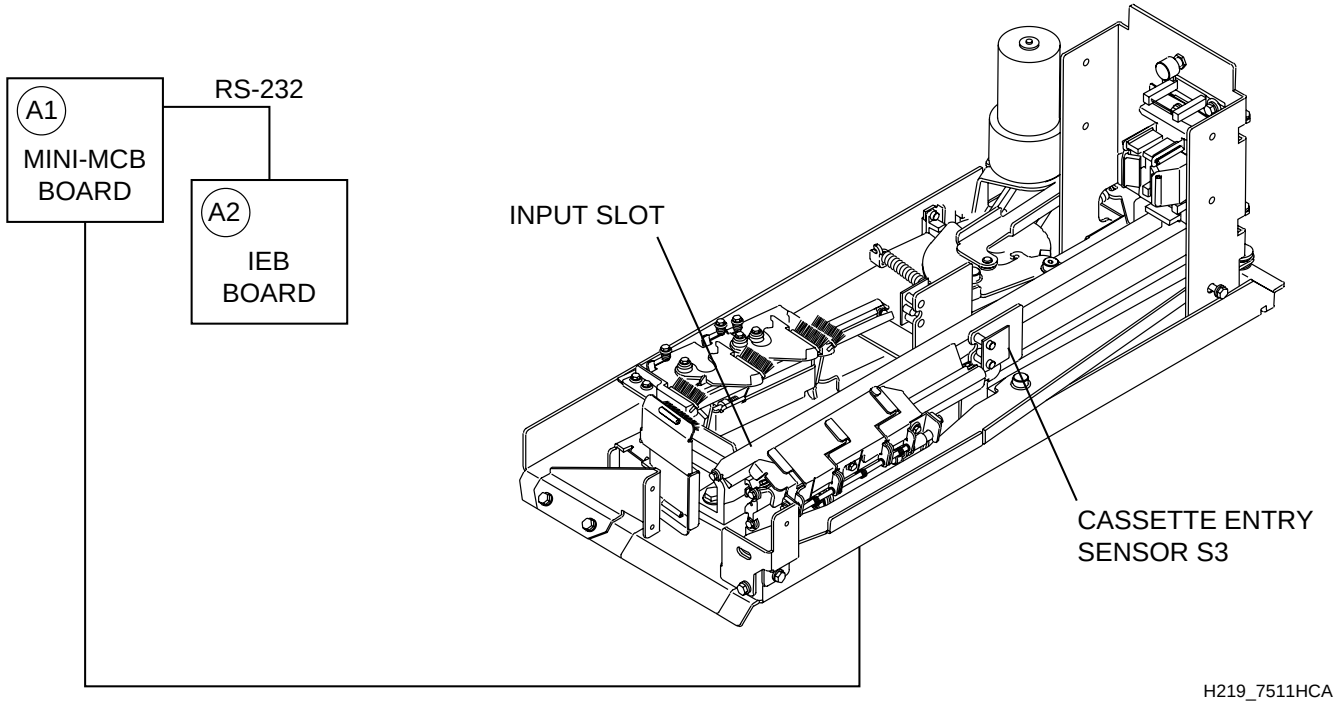
The CASSETTE HANDLING SYSTEM locates the CASSETTE in the correct position in the CLASSIC/ELITE CR SYSTEM, removes the PLATE from the CASSETTE and scans the SCREEN. The CASSETTE HANDLING SYSTEM includes the following systems:

- **CASSETTE Load**
- **EXTRACTION BAR MOTOR AY**
- **CLAMP MOTOR**
- **PLATE HANDLING**

Overview of operation:

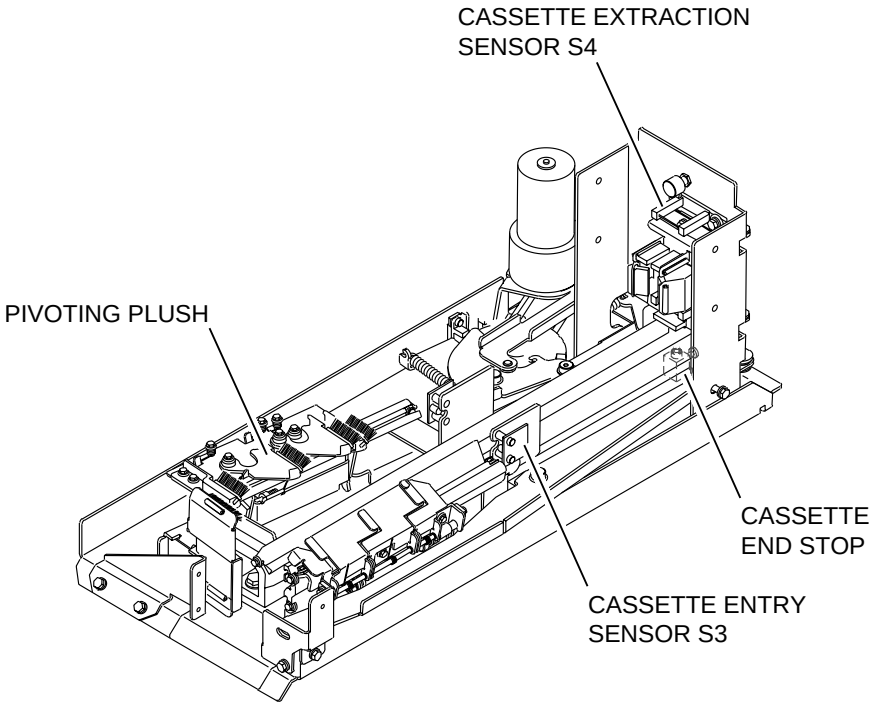
1. The operator inserts the CASSETTE into the INPUT SLOT of the CLASSIC/ELITE CR SYSTEM.
2. The SENSORS detect that the CASSETTE is fully inserted into the INPUT SLOT:
   - CASSETTE ENTRY SENSOR S3
   - CASSETTE EXTRACT SENSOR S4
3. The CLAMP MOTOR closes the CLAMP BAR on the CASSETTE.
4. The EXTRACTION BAR fastens onto the PLATE and moves it down during scanning.
5. After scanning and erasing, the EXTRACTION BAR returns the PLATE to the CASSETTE.
6. The CLAMP MOTOR opens the CLAMP BAR to release the CASSETTE.
7. The CASSETTE is available for the operator to remove.

CASSETTE Load



H219_7511HCA
H219_7511HC

The CASSETTE ENTRY SENSOR S3 detects that a CASSETTE is loaded and sends information about the CASSETTE to the MINI-MCB BOARD A1 and the IEB BOARD A2.



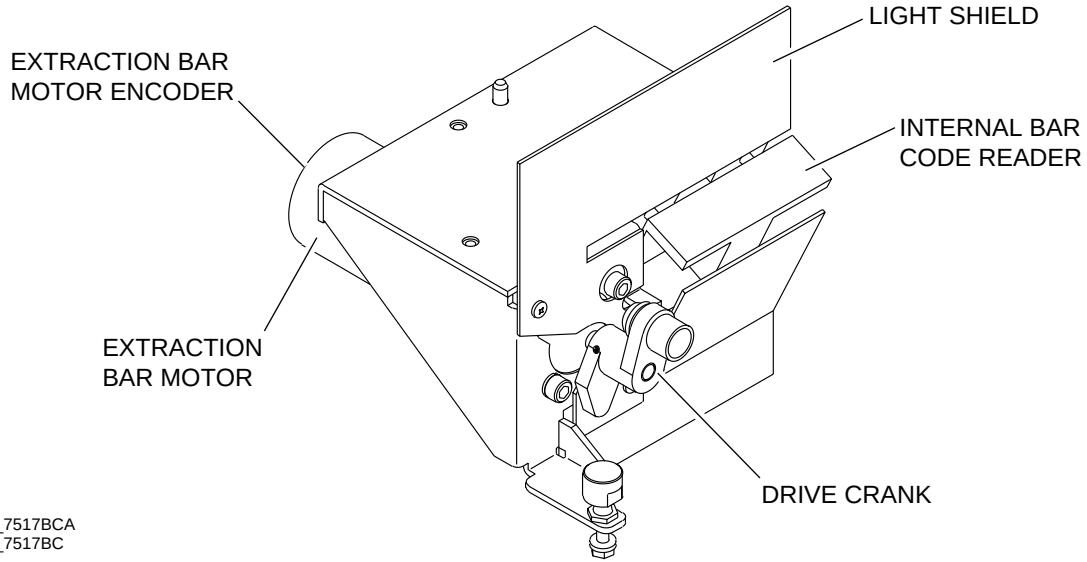
H219_7512HCA
H219_7512HC

Component	Description
INPUT SLOT	The operator slides the CASSETTE into the INPUT SLOT.
CASSETTE ENTRY SENSOR S3	The CASSETTE ENTRY SENSOR S3 is continually monitored to detect a CASSETTE. When a CASSETTE is inserted, the light beam of S3 is blocked.
CASSETTE EXTRACT SENSOR S4	The CASSETTE EXTRACT SENSOR S4 detects that the CASSETTE is fully inserted into the INPUT SLOT.
PIVOTING PLUSH	When the CASSETTE is in scan position, the PIVOTING PLUSH makes a light-tight environment around all sides of the CASSETTE. The PIVOTING PLUSH has FIBERS fastened to BARS on each side of the CASSETTE. To prevent light from reaching the SCREEN when it is removed from the CASSETTE, the PIVOTING PLUSH rotates toward the CASSETTE.

1. The operator inserts a CASSETTE into the INPUT SLOT.
2. When the CASSETTE ENTRY SENSOR S3 is blocked by the CASSETTE, a “Cassette Detected” message is sent to the MINI-MCB BOARD A1.
3. The MINI-MCB BOARD A1 sends a signal to the INTERNAL BAR CODE READER, which then reads the BAR CODE LABEL on the CASSETTE.
4. The INTERNAL BAR CODE READER sends the information about the CASSETTE to the MINI-MCB BOARD A1.
5. The system emits a beep.
6. The MINI-MCB BOARD A1 sends:
   - “Cassette Detected” message to the IEB BOARD A2
   - CASSETTE ID to the IEB BOARD A2
7. The IEB BOARD A2 sends:
   - “Cassette Detected” message to the MINI-MCB BOARD A1
   - “Scan Request” message to the EXTERNAL PC

8. The EXTERNAL PC:
   - checks that it has the quantity of memory necessary to receive an image
   - makes a raw image file to receive the image
   - sends a “Scan Request Reply” message to the IEB BOARD A2 with a value of “OK”
9. The MINI-MCB BOARD A1 sends a signal to the CLAMP MOTOR to rotate the SENSOR DRIVE PLATE counterclockwise until detected by the CLAMP CLOSED SENSOR S2. The CLAMP BAR and the PIVOTING PLUSH are closed.
10. After scanning, the MINI-MCB BOARD A1 sends a signal to the CLAMP MOTOR to rotate the SENSOR DRIVE PLATE clockwise until detected by the CLAMP OPEN SENSOR S1. The CLAMP BAR and the PIVOTING PLUSH are opened.

EXTRACTION BAR MOTOR AY



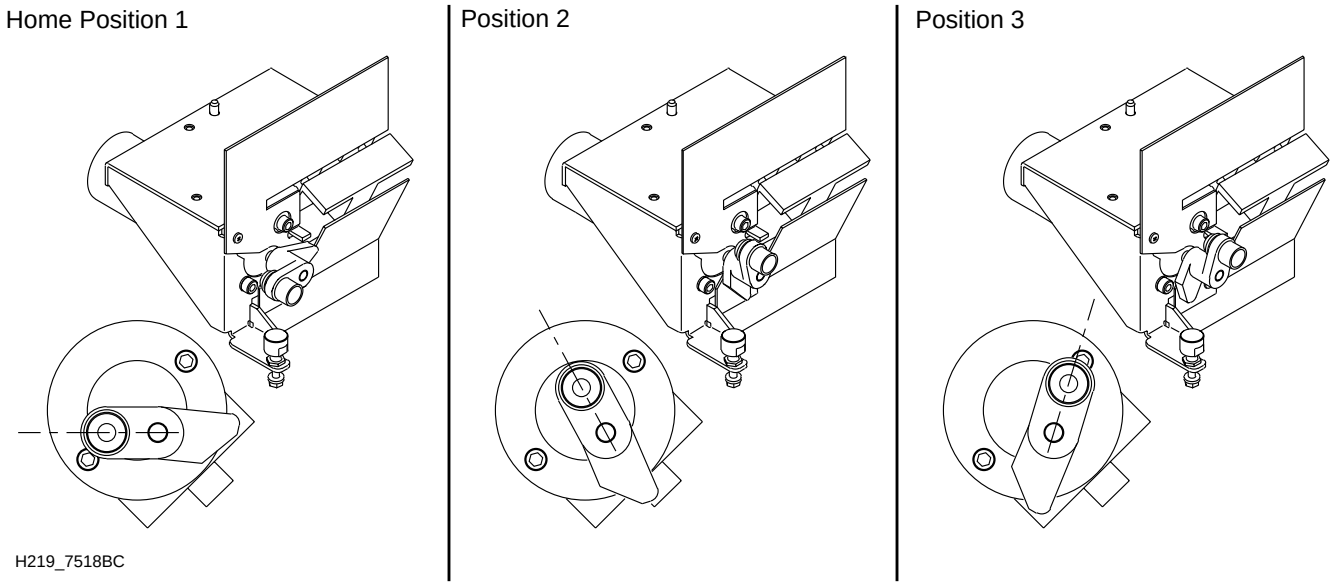
H219_7517BCA
H219_7517BC

The EXTRACTION BAR MOTOR AY moves the EXTRACTION BAR HOOKS that pull the PLATE from the CASSETTE for scanning the SCREEN.

Component	Description
DRIVE CRANK	The DRIVE CRANK engages the HOOK PLATE and moves it to the positions necessary to “latch” and “unlatch” the PLATE from the CASSETTE.
LIGHT SHIELD	The LIGHT SHIELD decreases internal light reflectance from the ERASE LAMPS.
EXTRACTION BAR MOTOR ENCODER	The EXTRACTION BAR MOTOR ENCODER sends information about the position of the EXTRACTION BAR MOTOR to the MINI-MCB BOARD A1.

Component	Description
INTERNAL BAR CODE READER	The INTERNAL BAR CODE READER: • is a component of the EXTRACTION BAR MOTOR AY • reads the bar code information from the BAR CODE LABEL on the CASSETTE • sends the bar code information to the IEB BOARD A2 • sends the bar code information to the MINI-MCB BOARD A1 using an RS-232 connection

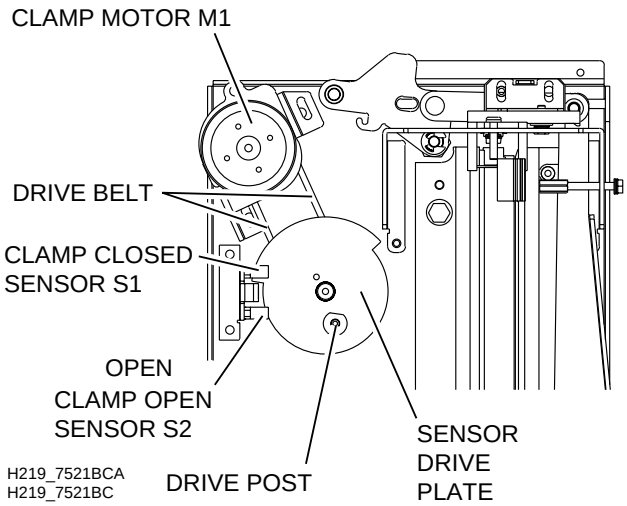
Figure 1 **Positions of the EXTRACTION BAR MOTOR**



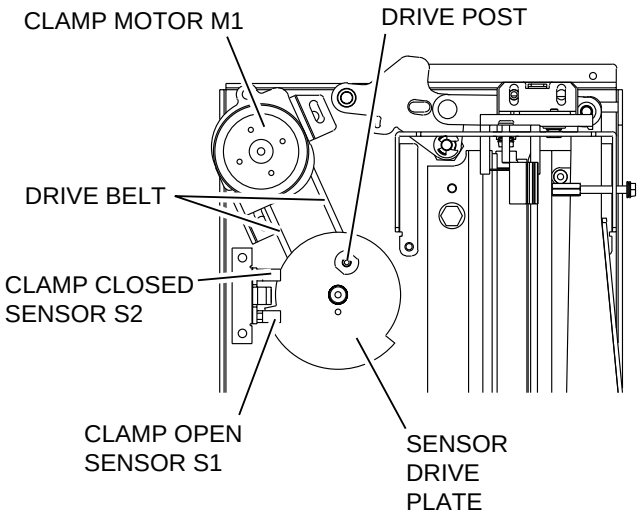
EXTRACTION BAR MOTOR	The EXTRACTION BAR MOTOR moves the DRIVE CRANK to each of 3 positions: • **Home Position 1** - HOOKS are retracted. • **Position 2** - HOOKS are in position to “latch” the PLATE. • **Position 3** - HOOKS are in position to “unlatch” the PLATE.

CLAMP MOTOR

CLAMP CLOSED POSITION



CLAMP OPEN POSITION



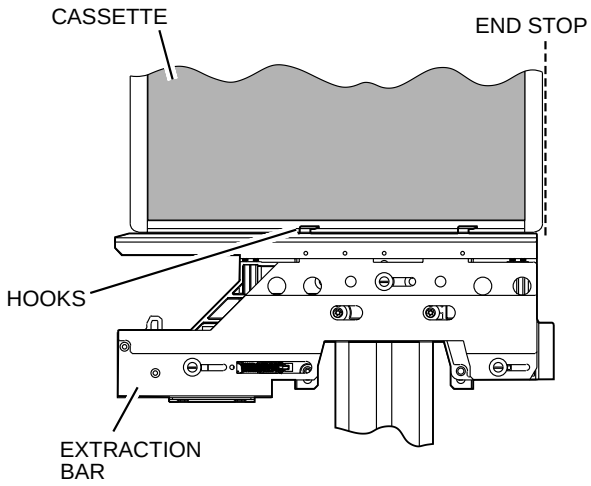
The CLAMP MOTOR M1 energizes to either open or close the CLAMP BAR.

Component	Description
CLAMP MOTOR M1	The CLAMP MOTOR M1 energizes to rotate the SENSOR DRIVE PLATE: • counterclockwise to close the CLAMP BAR • clockwise to open the CLAMP BAR
CLAMP OPEN SENSOR S1	The CLAMP OPEN SENSOR S1 detects when the CLAMP BAR is fully open.
CLAMP CLOSED SENSOR S2	The CLAMP CLOSED SENSOR S2 detects when the CLAMP BAR is fully closed.
SENSOR DRIVE PLATE	The SENSOR DRIVE PLATE rotates to actuate either: • CLAMP OPEN SENSOR S1 • CLAMP CLOSED SENSOR S2

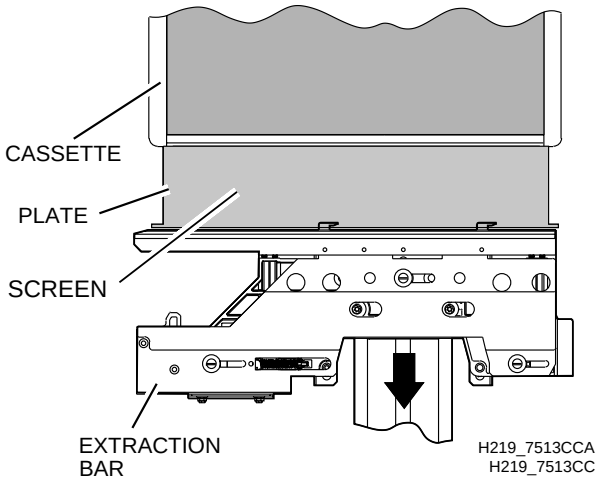
1. The operator inserts the CASSETTE into the INPUT SLOT.
2. The SENSORS detect that the CASSETTE is fully inserted:
   - CASSETTE ENTRY SENSOR S3
   - CASSETTE EXTRACT SENSOR S4
3. The MINI-MCB BOARD A1 energizes the CLAMP MOTOR M1 to rotate the SENSOR DRIVE PLATE counterclockwise to close the CLAMP BAR.
4. To open the CLAMP BAR, the MINI-MCB BOARD A1 energizes the CLAMP MOTOR M1 to rotate the SENSOR DRIVE PLATE clockwise.

PLATE HANDLING

Fastening the PLATE
to the EXTRACTION BAR



Pulling the SCREEN
Down for Scanning

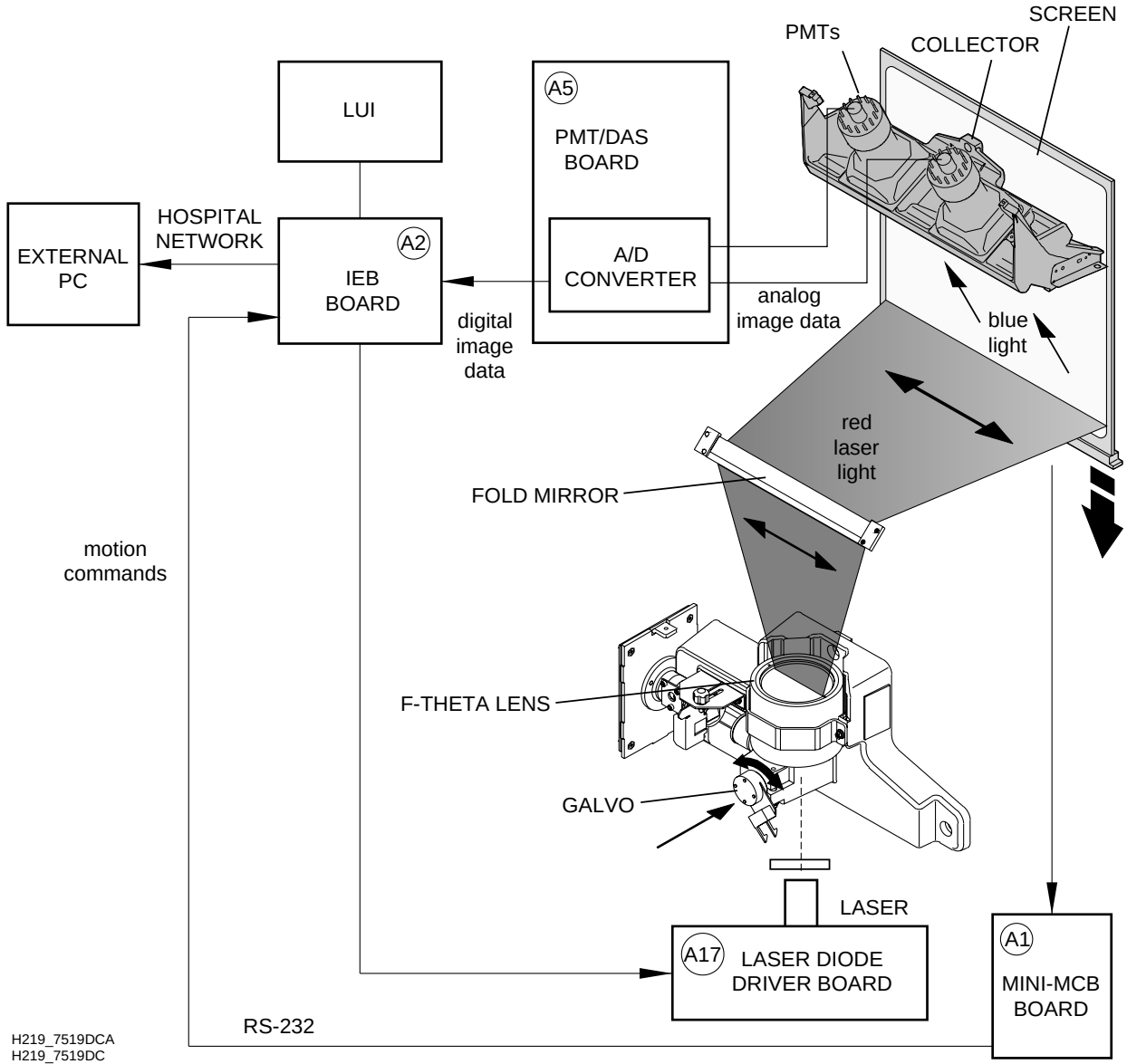


The PLATE HANDLING components remove the PLATE from the CASSETTE SHELL and fasten it to the EXTRACTION BAR.

The EXTRACTION BAR holds the PLATE during the scanning operation, then inserts it back into the CASSETTE SHELL.

Section 6: Optical

Overview



H219_7519DCA
H219_7519DC

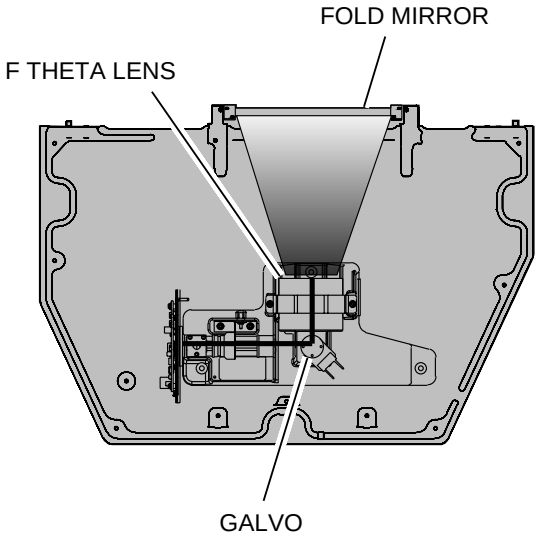
The OPTICAL subsystem:

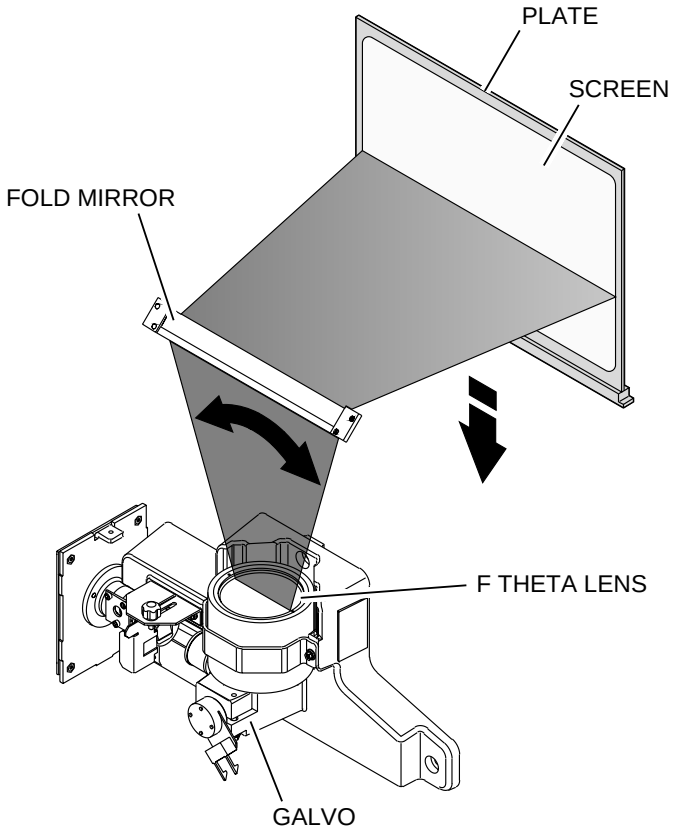
- generates the laser beam and provides the deflection of the beam onto the SCREEN
- moves the laser beam across the SCREEN at a controlled rate to release the stored energy in the PHOSPHOR
- obtains the image by capturing the light that was released and changing it to a digital format

The OPTICAL subsystem includes the following main components:

- **LASER**
- **GALVO**
- **COLLECTOR and PHOTOMULTIPLIER TUBE (PMT)**

LASER

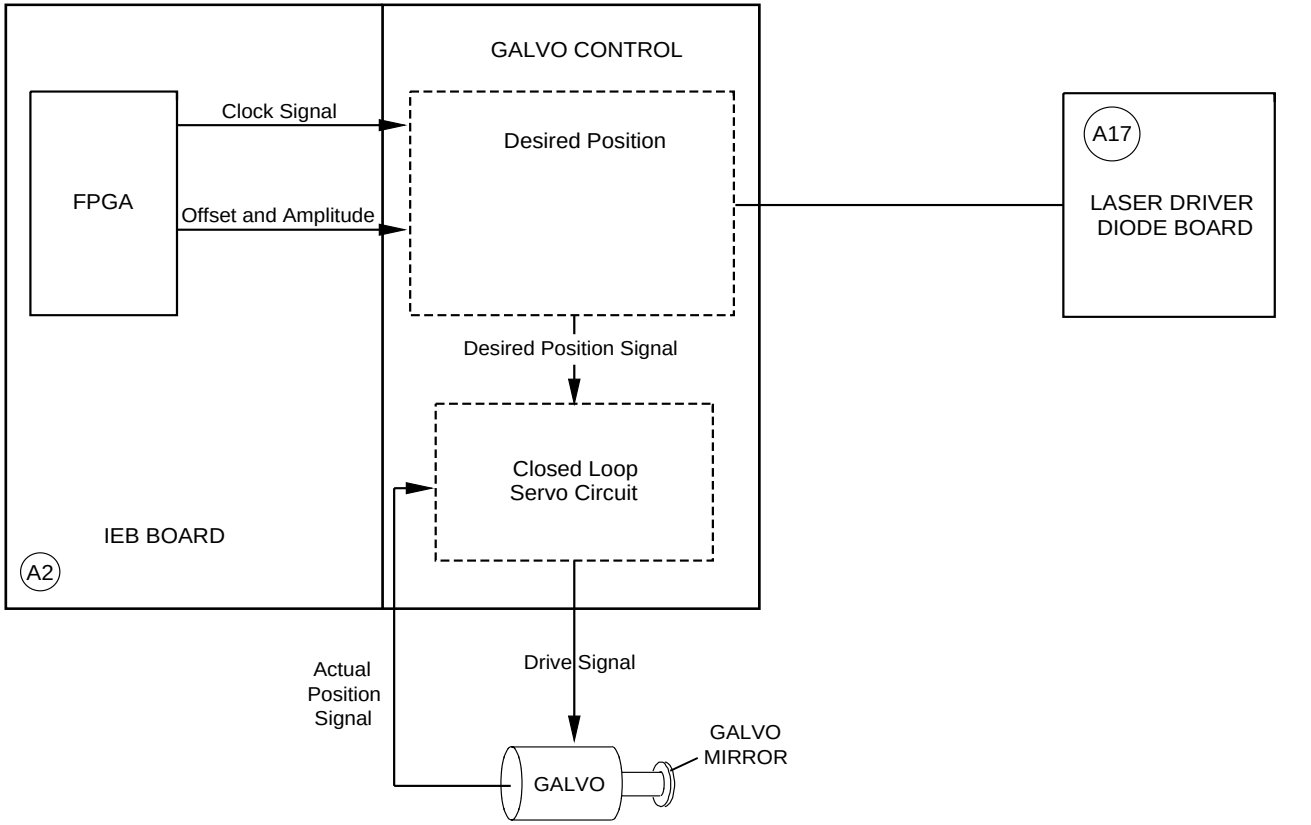




H219_7514HCA
H219_7514HC

Component	Description
LASER	Type 30 mW LASER DIODE DRIVER BOARD that emits a red beam of high intensity light. The IEB BOARD A2 controls the power of the LASER: • Threshold" - supplies minimum power when the LASER is moving to the start of the next line - retrace • "Scan" - supplies full power to the LASER during scanning • "Full-on" - used for diagnostics
COLLIMATING OPTICS	Provides focus for the light beam to make the spot of light the correct size on the SCREEN.
MANUAL SAFETY SHUTTER	Has a NEUTRAL DENSITY FILTER that decreases the power of the light emitted by the LASER. When you check the operation of the OPTICAL subsystem, you can change the position of the SHUTTER to make the light from the LASER move through the FILTER. The FILTER decreases the power of the LASER, which prevents damage to the eyes. The graphic on **Page 53** indicates the position of the MANUAL SAFETY SHUTTER when it is in the path of the LASER. During normal operation of the CLASSIC/ELITE CR SYSTEM, the MANUAL SAFETY SHUTTER does not block the path of the LASER.
GALVO	Controls the motion of the light beam from the LASER across the SCREEN in the fast scan direction - horizontal.
F-THETA LENS	Changes the light beam from the LASER from a continual angular position to a continual linear position.
FOLD MIRROR	Changes the direction of the light beam from the LASER to align it in the center of the COLLECTOR.

GALVO



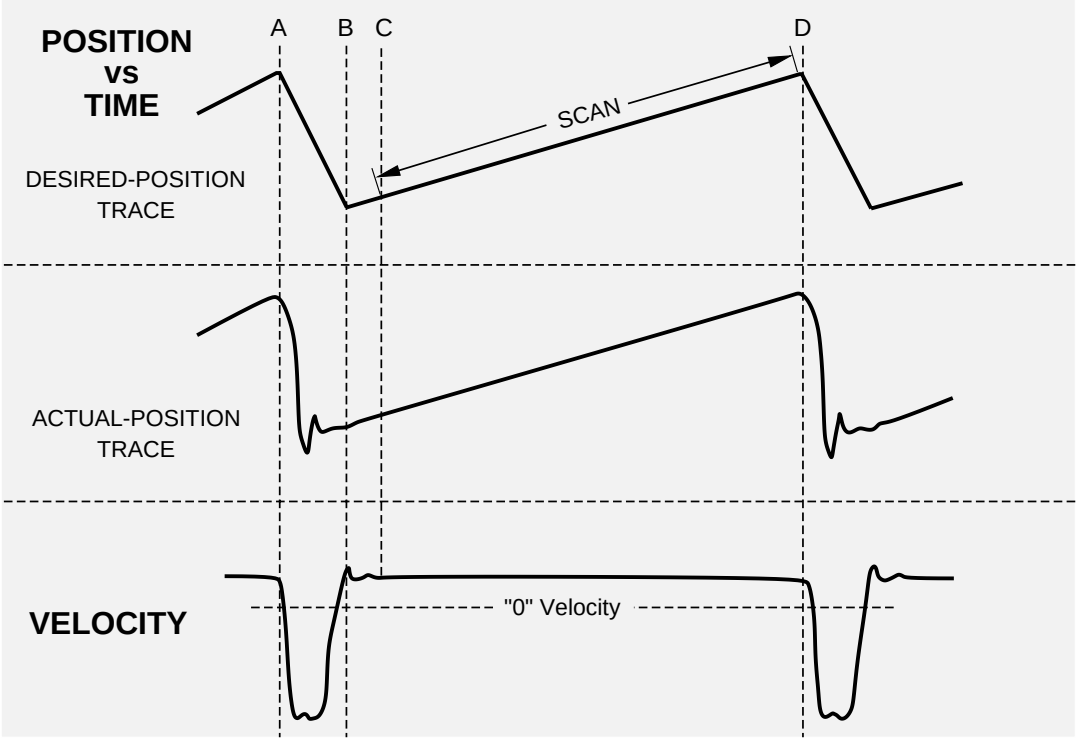
The GALVO moves the laser beam to scan the SCREEN:

- rotates the GALVO MIRROR to cause the laser beam to scan across the SCREEN - fast scan
- moves to the beginning of the next line on the SCREEN
- scans the next line until the SCREEN is fully scanned

The GALVO uses a feedback system in which the **desired** position of the GALVO MIRROR is compared to the **actual** position in the rotation, and corrections are made to keep the GALVO in the correct position on the SCREEN at the correct time. When the GALVO is in the correct position, the laser beam is also in the correct position.

Component	Description
GALVO	Includes: • MOTOR - rotates the SHAFT • SHAFT - has a MIRROR at one end to send the laser beam toward the F-THETA LENS
IEB BOARD A2	Includes a feedback circuit that controls the position of the GALVO MIRROR. The position of the GALVO MIRROR determines the position of the laser beam. The IEB BOARD A2 uses the following information to define the **desired** position of the GALVO MIRROR: • clock signal from the FPGA, which moves the GALVO through the **desired** position between the offset and amplitude. • values for the PLATE size, which were set up during calibration: – offset - starting point – amplitude - the distance to move across the SCREEN Information from POSITION SENSORS determine the position of the GALVO SHAFT in the scan - the **actual** position. The **actual** position is compared to the **desired** position and corrections in position are made to provide a smooth motion of the beam.

Traces in the Operation of the GALVO



H219_7503HC

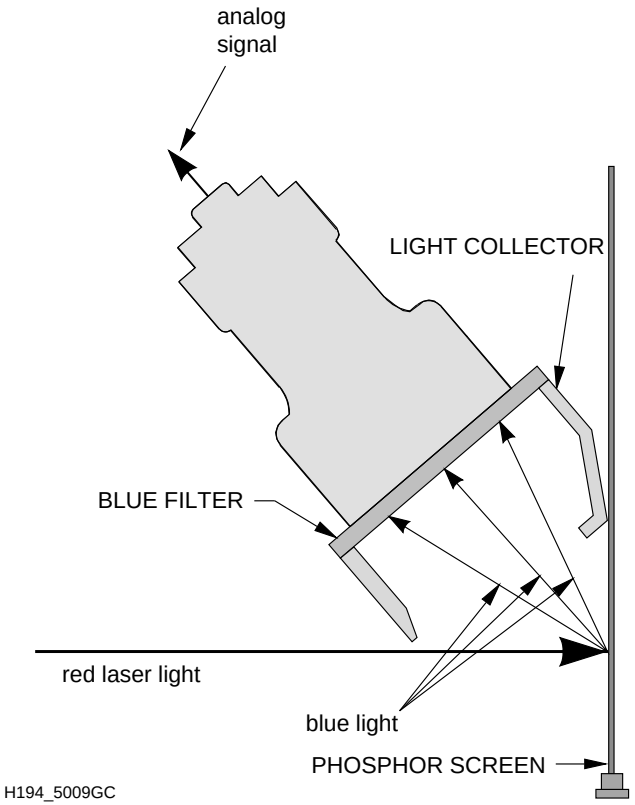
The following table describes the positions within the 3 traces.

Traces of the GALVO	Description
Desired position trace	• **position A** - the FPGA has sent a signal to the GALVO control to retrace • **between Positions A and B** - the system is moving the GALVO to complete the retrace • **between Positions B and C** - the speed of the GALVO is increasing to operating speed • **position C** - the PIXEL CLOCK starts and the PMT/DAS BOARD A5 starts measuring the pixel data from the SCREEN. The laser beam is at the edge of the SCREEN • **between Positions C and D** - the complete line of pixels is scanned • **position D** - the laser beam is at the other edge of the PLATE and the PIXEL CLOCK stops
Actual position trace	• matches the desired position trace during scanning of the SCREEN • does not match the desired position trace between Positions A and B, indicating the time necessary for the GALVO to be stable and start moving across the next line
Velocity trace	• GALVO is moving in the scanning direction when the trace is above the “0 Velocity” line in the diagram • GALVO is moving in the retrace direction when the trace is below the “0 Velocity” line • GALVO is moving at a constant speed during scanning • the speed of the GALVO increasing to operating speed between Positions B and C • the difference between the scanning and retrace speed is larger than it appears in the diagram

COLLECTOR and PHOTOMULTIPLIER TUBE (PMT)

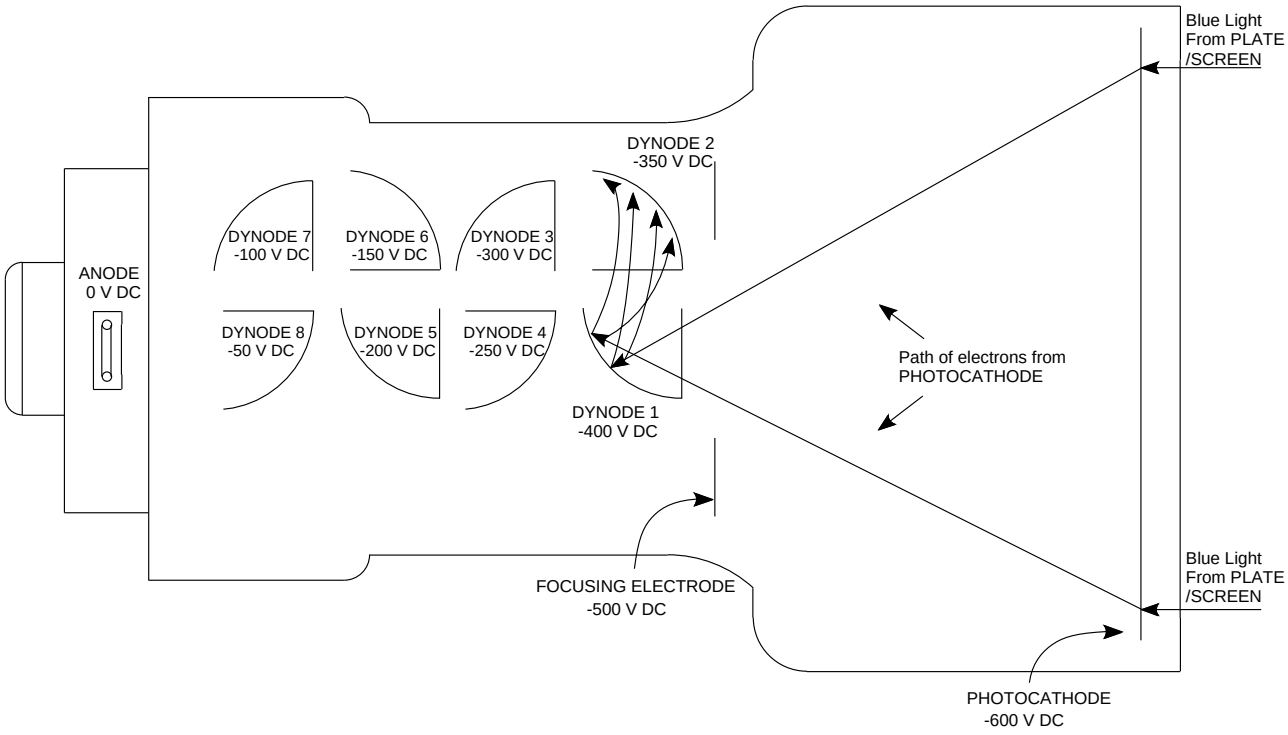
The COLLECTOR and the PMTs:

- provide the collection of the blue light emitted from the PHOSPHOR SCREEN
- measure the brightness of the blue light
- change the measurement of brightness to a proportional electrical signal



Component	Description
IEB BOARD A2	Controls the operation of the PMT/DAS BOARD A5 to provide for the measurement and collection of image data at the correct time: • sends a signal to the GALVO to rotate the GALVO MIRROR to move the laser beam in the fast scan direction across the SCREEN • sends a signal to the PMT/DAS BOARD A5 to measure the emitted light at controlled times. Each measurement makes a pixel in the completed image.
LIGHT COLLECTOR	Provides the collection of the blue light emitted from the SCREEN and sends it toward the PMTs. The inside surface of the COLLECTOR is reflective.
BLUE FILTER	Removes any red laser light reflected from the SCREEN, allowing only the blue light to reach the PMTs.
PHOTOMULTIPLIER TUBES (PMT)	2 LIGHT SENSORS, which emit a current signal corresponding to the light reaching the FACE of the PMT. The PMTs use a high-voltage POWER SOURCE to operate. The voltage of the POWER SOURCE determines the sensitivity of the PMTs.
PMT/DAS BOARD A5	Changes analog signals from the PMTs to digital format: • amplifies the signals from the 2 PMTs • adds the signals from the PMTs • filters the summed signal • changes the summed signal to a digital format

Collection of the Blue Light



H194_5043HC

When the red light from the LASER reaches the SCREEN, blue light is emitted in random directions. The COLLECTOR captures most of the rays of blue light and provides the deflection of the rays toward the FACE of the PMTs.

Changing the Blue Light to Electrical Current

1. Some of the red light from the LASER that reaches the SCREEN is reflected and enters the COLLECTOR. A BLUE FILTER between the COLLECTOR and the PMTs rejects most of the red light and allows the blue light to enter. The PMTs receive only the blue light from the SCREEN.

2 Inside the PMT are a number of components that are connected to varying levels of high voltage. The circuits on the PMT/DAS BOARD A5 separate the high voltage into a descending series of voltages. These voltages are connected to components in the PMT. In the graphic, examples of voltages are listed.

Note

The HIGH VOLTAGE POWER SUPPLY provides a high negative voltage limited to lower than 2 mA. The PHOTOCATHODE is connected directly to the -600 V source. The FOCUSING ELECTRODE in the PMT is set to -500 V. Next to the FOCUSING ELECTRODE are a series of DYNODES, which are set at decreasing voltages until at the end is an ANODE which is set at 0 V.

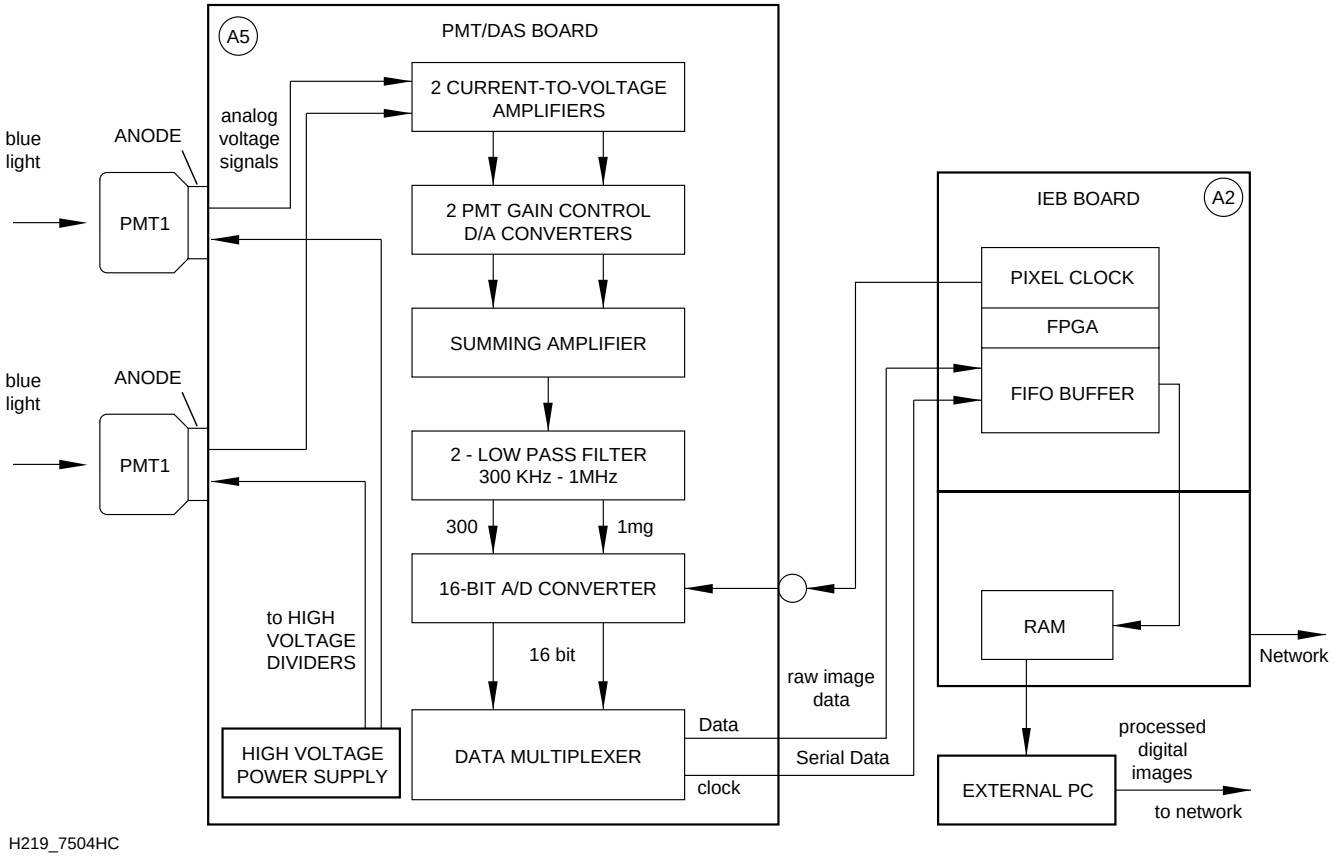
3 The PHOTOCATHODE emits an ELECTRON when it is hit by a light PHOTON. Because the efficiency of the PHOTOCATHODE is less than 100%, the number of ELECTRONS is less than the number of PHOTONS entering the PMT.

4 The negatively charged ELECTRON is influenced by the electrical field between the PHOTOCATHODE at -600 V and the more positive FOCUSING ELECTRODE at -500 V, pulling the ELECTRON toward the FOCUSING ELECTRODE.

5 When the ELECTRON moves toward the FOCUSING ELECTRODE, it is pulled by the more positive DYNODE. When the ELECTRON hits the DYNODE surface, it reflects from the surface and emits more ELECTRONS. At each DYNODE, the number of ELECTRONS increases, more electrons are added, and all the ELECTRONS are attracted to the next more positive DYNODE.

6 At the end of the PMT, all the ELECTRONS are attracted to the ANODE, which assembles the ELECTRONS and sends the ELECTRONS to the PMT/DAS BOARD A5 in a small current signal.

Operation of the PMT/DAS BOARD A5:

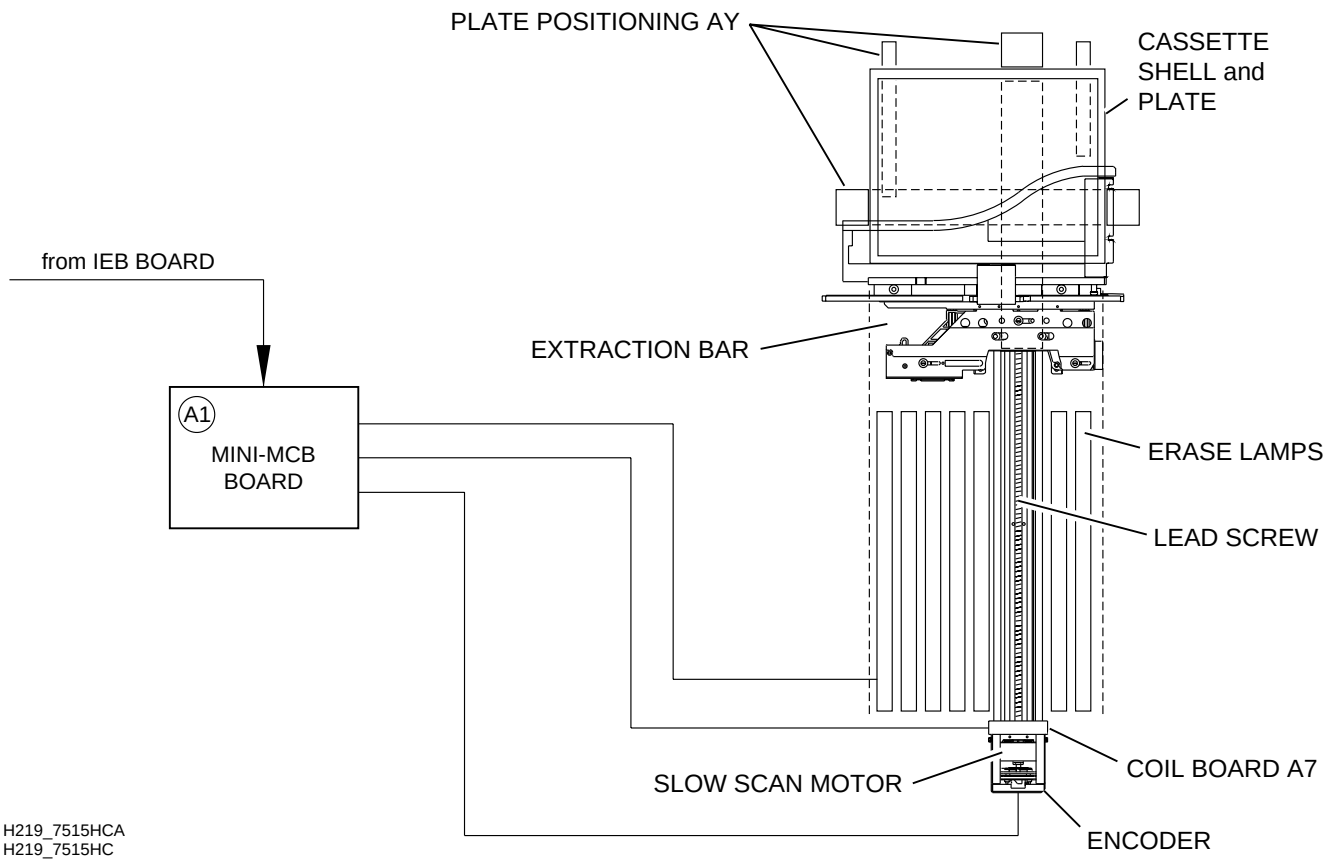


1. The 2 PMTs connect to the PMT/DAS BOARD A5. The HIGH VOLTAGE POWER SUPPLY feeds power to the HIGH VOLTAGE DIVIDERS. Each PMT has a HIGH VOLTAGE DIVIDER that sends the given levels of high voltage to the components inside the PMTs.
2. The ANODE of each PMT is connected to a CURRENT-TO-VOLTAGE AMPLIFIER, which changes the small current signal from each PMT into a corresponding voltage signal. Each of the voltage signals moves through a PMT GAIN CONTROL D/A CONVERTER. These CONVERTERS change the signal level from each PMT to adjust for gain variations from PMT to PMT.

3. The corrected signals are added together in the SUMMING AMPLIFIER. An offset adjustment signal is added to adjust for any other offset error. The offset signal is provided by 2 D/A CONVERTERS that allow large and small adjustments. The offset adjustment signal causes the signal to be 0 when no light hits the PMTs.
4. The adjusted signal is sent through the correct LOW PASS FILTER for noise reduction:
   - GP resolution - 300 KHz
   - EHR - 1 MHz
5. The filtered signal is sent to the 16-BIT A/D CONVERTER for measurement of the brightness of the blue light emitted by the SCREEN. The intensity of the blue light is proportional to the charge stored by the PHOSPHOR and the intensity of the laser beam that hit the PHOSPHOR. To construct the original image again, it is necessary to know the strength of the laser beam when the blue light was measured.
6. The PMT/DAS BOARD A5 includes logic circuits that interface with the IEB BOARD A2. This serial data interface allows for the adjustment of the A/D CONVERTERS on the PMT/DAS BOARD A5. The PIXEL CLOCK connects to the A/D CONVERTER and sends a command to make a measurement. The A/D CONVERTER makes a 16-bit value for each measurement.
7. The image is sent to the IEB BOARD A2 in serial format one pixel at a time. The data is stored in a FIFO BUFFER until a complete line of data is received. The raw image data is sent to the RAM. When all the data for a given image is in the RAM, the IEB BOARD A2 sends the full raw image to the EXTERNAL PC for processing and distribution to the hospital network.

Section 7: Scan/Erase

Overview



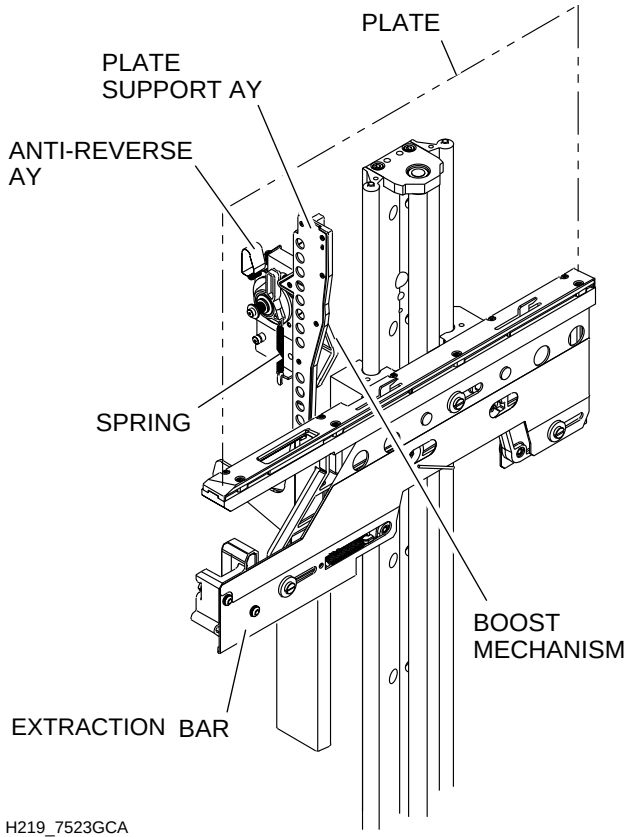
The Scan/Erase subsystem moves the PLATE:

- through the field of scan at a constant speed
- to the ERASE AY to be erased
- up to be inserted into the CASSETTE SHELL

The Scan/Erase subsystem includes:

- **PLATE SUPPORT AY - Version 1**, or
- **PLATE SUPPORT AY - Version 2**
- **LEAD SCREW**
- **EXTRACTION BAR**
- **REFERENCE SENSOR S5**
- **PLATE PRESENT SENSOR S6**
- **SLOW SCAN MOTOR**
- **ENCODER**
- **ERASE AY**
- **LAMP CURRENT SENSORS CS1 - CS5**

PLATE SUPPORT AY - Version 1



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H219_7523GC

The ARM of the PLATE SUPPORT AY keeps the PLATE in the correct vertical position for removal from the CASSETTE, for scanning, and for inserting the PLATE into the CASSETTE SHELL after scanning.

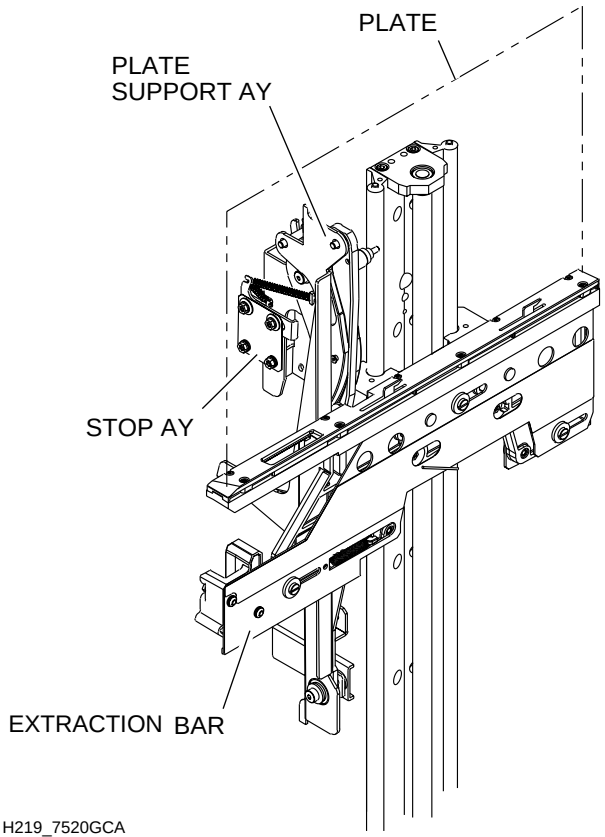
The PLATE SUPPORT AY has a single ARM. A ROLLER BEARING on the SLOW SCAN AY controls the position of the ARM.

The ARM rotates forward until it touches the back of the PLATE. After the ARM touches the PLATE, the ROLLER BEARING releases contact with the ARM, and the SPRING for the ANTI-REVERSE AY holds the contact between the ARM and the PLATE.

The ANTI-REVERSE AY:

- prevents the ARM from moving backward
- has a BOOST MECHANISM that lightly pushes the PLATE toward the COLLECTOR to create clearance between the PLATE and the CASSETTE. The clearance prevents the PLATE from touching the WALLS of the CASSETTE when the PLATE moves out of the CASSETTE.

PLATE SUPPORT AY - Version 2



H219_7520GCA
H219_7520GC

The ARM of the PLATE SUPPORT AY keeps the PLATE in the correct vertical position for removal from the CASSETTE, for scanning, and for inserting the PLATE into the CASSETTE SHELL after scanning.

A ROLLER BEARING on the SLOW SCAN AY controls the position of the PLATE SUPPORT AY.

When the SLOW SCAN AY moves down to remove the PLATE from the CASSETTE, the PLATE SUPPORT AY rotates forward until it touches the back of the PLATE. After the PLATE SUPPORT AY touches the PLATE, it continues to move forward until it touches the STOP AY.

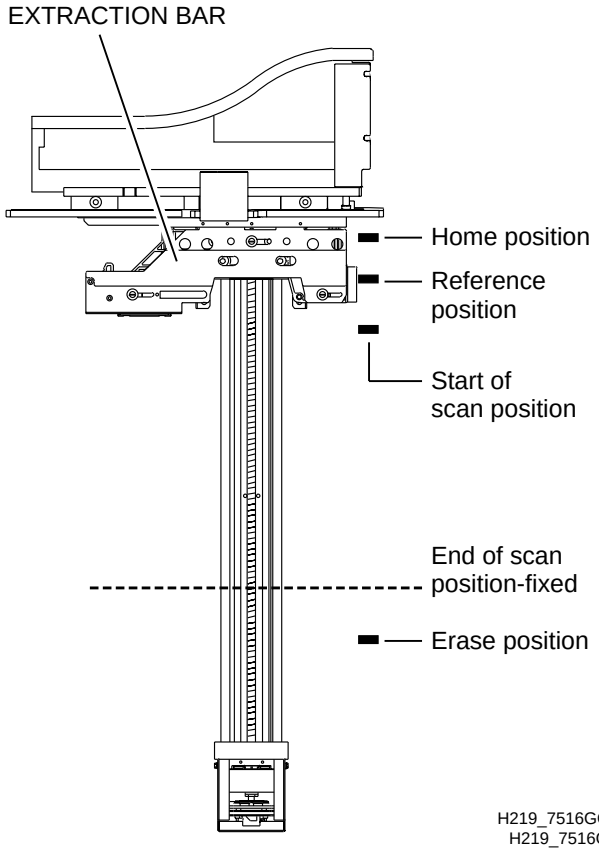
The PLATE SUPPORT AY has 2 main components:

- MOUNTING ARM - after the POSITIONING ARM touches the PLATE, the MOUNTING ARM stops moving. The SLOW SCAN AY continues to remove the PLATE from the CASSETTE.
- SUPPORT ARM - as the SLOW SCAN AY continues to remove the PLATE from the CASSETTE, the SUPPORT ARM continues to rotate forward until it reaches the STOP. The SUPPORT ARM pushes the PLATE from the back of the CASSETTE SHELL when it leaves the CASSETTE.

LEAD SCREW

The LEAD SCREW is connected to the MOTOR SHAFT. When the LEAD SCREW rotates, it moves the EXTRACTION BAR up and down.

EXTRACTION BAR



The EXTRACTION BAR holds the PLATE when it moves down during scanning and up after erasing.

Note

The PLATE is not visible in the graphic.

The EXTRACTION BAR has 5 vertical positions.

Position of the EXTRACTION BAR	Description
Reference position	Position of the EXTRACTION BAR when the REFERENCE SENSOR S5 is blocked. The REFERENCE SENSOR S5 is installed at this position during manufacture. This position is not the same for all CLASSIC/ELITE CR SYSTEMS. When the system is initialized, the EXTRACTION BAR checks for the REFERENCE SENSOR S5. Once it is located, the EXTRACTION BAR moves up to the home position 1. The EXTRACTION BAR remains at the home position 1 until the start of a new cycle.
Home position	Position of the EXTRACTION BAR at the start and end of a cycle. Home position is 3.8 - 4.5 cm (1.5 - 1.75 in.) above the position of the REFERENCE SENSOR. The home position is set in the factory, but can be adjusted in the field if necessary.
Start of scan position	Position of the EXTRACTION BAR when the SCREEN is in position to be scanned. The start of scan position is a set number of counts of the ENCODER below home position. The number of counts of the ENCODER defines the **mechanical** start of scanning. The **optical** start of scanning occurs after the IEB BOARD A2 sends a message to the GALVO to start scanning the SCREEN. For more information about the ENCODER, see **ENCODER**.
End of scan position	The end of scan is defined by counts of the ENCODER, determined by the size of the PLATE.
Erase position	Position below the end of scan when the PLATE is located directly in front of the ERASE LAMPS. The erase position is determined by the size of the PLATE.

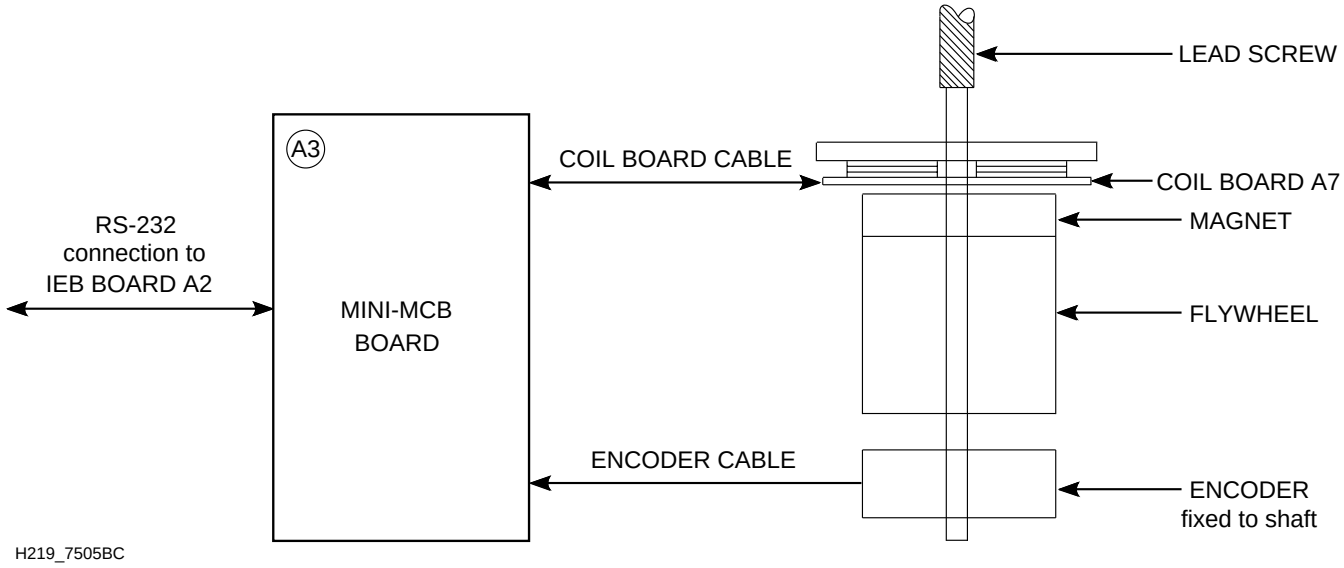
REFERENCE SENSOR S5

The REFERENCE SENSOR S5 checks for a FLAG on the EXTRACTION BAR that provides the SLOW SCAN AY with the reference position. All other positions of the SLOW SCAN AY are relative to the reference position.

PLATE PRESENT SENSOR S6

After the PLATE is fastened by the EXTRACTION BAR, it is pulled down by the SLOW SCAN AY. The PLATE moves between the EMITTER and DETECTOR of the PLATE PRESENT SENSOR S6. The MINI-MCB BOARD A1 reads the status of the SENSOR and determines if a PLATE is loaded before continuing the slow scan operation.

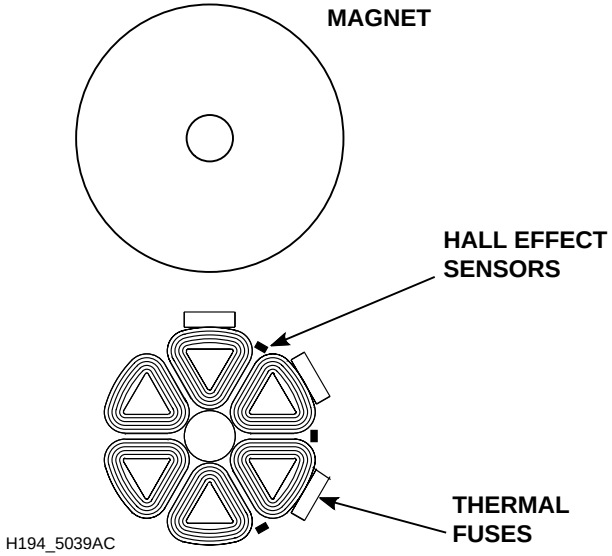
SLOW SCAN MOTOR



The SLOW SCAN MOTOR is a 3-phase DC MOTOR that provides all vertical motion of the PLATE necessary for scanning and erasing operations.

The following components control the operation of the SLOW SCAN MOTOR:

Component	Description
MINI-MCB BOARD A1	Controls the motions of the SLOW SCAN MOTOR. The COIL BOARD A7 and the ENCODER connect to this BOARD. Normally, the parameters of motion of the MOTOR include: • direction of motion - clockwise or counterclockwise • number of counts of the ENCODER that the MOTOR must move • acceleration • running speed • deceleration
SLOW SCAN MOTOR	Includes: • STEEL PLATE - operates with the COIL BOARD A7 to generate the MAGNET that causes torque in the SLOW SCAN MOTOR • COIL BOARD A7 - keeps the correct rotation of the SLOW SCAN MOTOR • MAGNET/FLYWHEEL - a steel CYLINDER with a MAGNET at the top end that adds rotating mass to the MOTOR and makes the rotation smooth
ENCODER	Monitors the speed and position of the MAGNET to provide: • smooth operation of the MOTOR • speed of the MOTOR that does not change



The COIL BOARD A7 includes:

- 6 TRIANGULAR-SHAPED COILS of wire around the CENTRAL SHAFT of the MOTOR
- 3 HALL EFFECT SENSORS, which detect magnetic fields. The SENSORS determine the position of the MAGNET POLES relative to the COILS
- 3 THERMAL FUSES, which protect the components if a COIL is too hot or other malfunctions occur

The COIL BOARD A7 and the MAGNET operate together to rotate the MOTOR.

1. The HALL EFFECT SENSORS determine the polarization of the MAGNET when the MAGNET is aligned with the COILS.
2. The MINI-MCB BOARD A1 changes the amplitude and direction of the current flow in the COILS to make a magnetic field.
3. The MAGNET rotates to align with the magnetic field.
4. The process continues, providing a smooth rotation of the MOTOR.

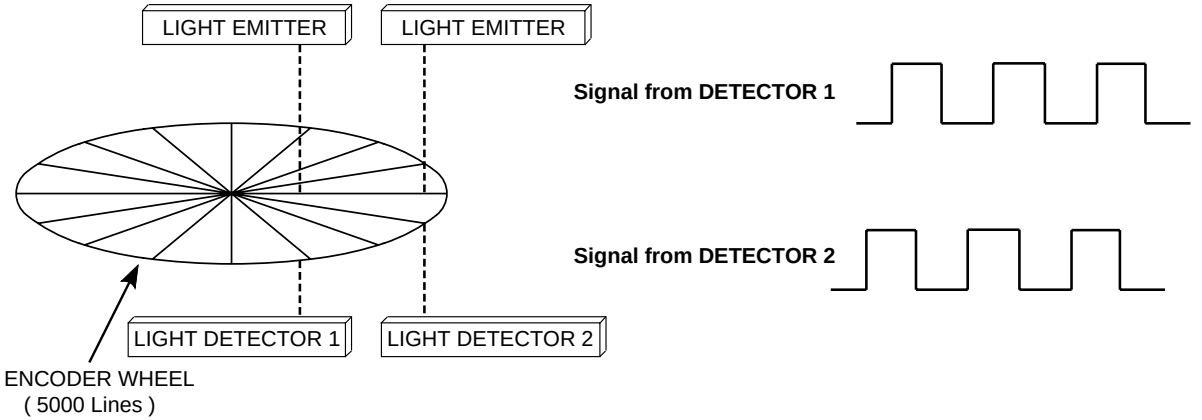
Obtaining Smooth Operation of the SLOW SCAN MOTOR

To obtain smooth operation of the SLOW SCAN MOTOR, it is necessary to have smooth rotating torque. The COILS make a magnetic field and the MAGNET aligns with the COILS. When the MAGNET POLES are almost in alignment with the magnetic field, the torque potential is highest. When the MAGNET rotates out of perfect alignment, more current is necessary in the COILS to provide the same quantity of torque.

To provide the smoothest torque, the MINI-MCB BOARD A1 uses a sinusoidal current in the COILS. When the polarization of the MAGNET is most out of alignment with the magnetic field of the COIL, the sinusoidal current is at the maximum. When the MAGNET and the field are almost perfectly aligned, the current drops to almost 0. The current in the COIL then changes to negative polarity to repel the MAGNET POLE and continue the smooth torque. When the next POLE starts to approach, the current reverses direction and reaches the maximum again.

The MINI-MCB BOARD A1 monitors the signals from the ENCODER when the MOTOR is operating. If the MOTOR is operating too slowly, the MINI-MCB BOARD A1 increases the peak of the COIL current sinuosity to provide more torque to increase the speed. If the MOTOR is operating at a higher speed than it should, it decreases the current.

ENCODER



The ENCODER monitors the speed and position of the MAGNET during rotation to provide smooth operation and continual speed.

Component	Description
ENCODER WHEEL	A clear disk that has 5000 lines leading from the center to the outside edge.
2 OPTICAL SENSORS - EMITTER/ DETECTORS	Placed at the edge of the ENCODER WHEEL. Each beam from the EMITTER/DETECTOR is blocked by the lines of the WHEEL when the WHEEL rotates.

The signals of the SENSORS are 90 degrees out of phase with each other in a “quadrature relationship.” One DETECTOR detects the **edge** of a line and the other detects the **middle** of the line.

The ENCODER determines:

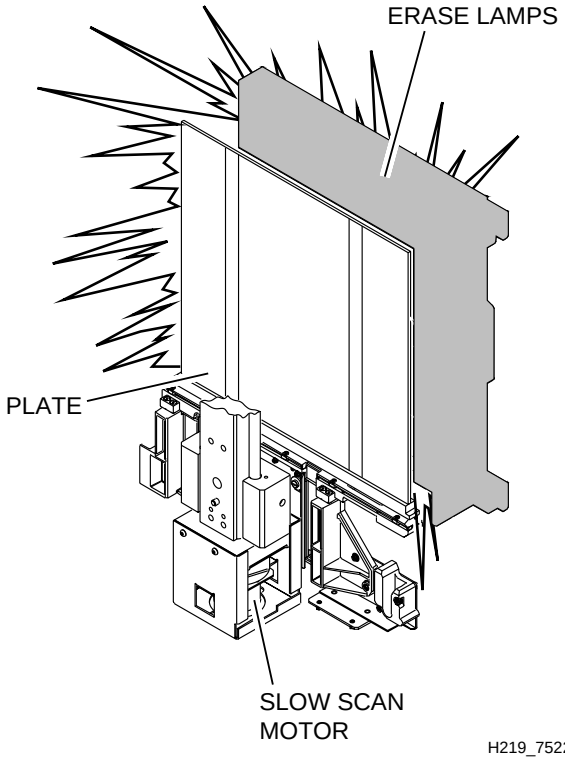
- speed of the SLOW SCAN MOTOR by measuring the frequency of the signals
- direction of rotation of the SLOW SCAN MOTOR by determining the sequence in which the signals change

The signals from the 2 SENSORS are continually monitored by the MINI-MCB BOARD A1, and the power to the COIL BOARD A7 is decreased or increased to provide smooth rotation and continual speed.

20,000 counts of the ENCODER make one rotation of the LEAD SCREW. The system moves to each of the following positions until it reaches the correct number of counts:

- start of scan
- erase
- end of scan

ERASE AY



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H219_7522GC

The ERASE AY includes 5 pairs of high-intensity ERASE LAMPS that expose the scanned SCREEN to white light. This operation releases any residual charge on the SCREEN.

1. The IEB BOARD A2 sends an “Erase” command to the MINI-MCB BOARD A1, which sends a signal to the SLOW SCAN MOTOR to start the erasing operation.
2. The SLOW SCAN MOTOR actuates and moves the PLATE into the erase position determined by the ENCODER counts.
3. The SLOW SCAN MOTOR stops and waits for a response from the IEB BOARD A2.
4. The IEB BOARD A2 sends the “Erase” command and time to the MINI-MCB BOARD A1, which actuates the ERASE LAMPS.
5. The ERASE LAMPS illuminate for 2 - 16 seconds to remove the image from the SCREEN.
6. When the SCREEN is erased, the MINI-MCB BOARD A1 sends the “Erase Done” status to the IEB BOARD A2.

Note

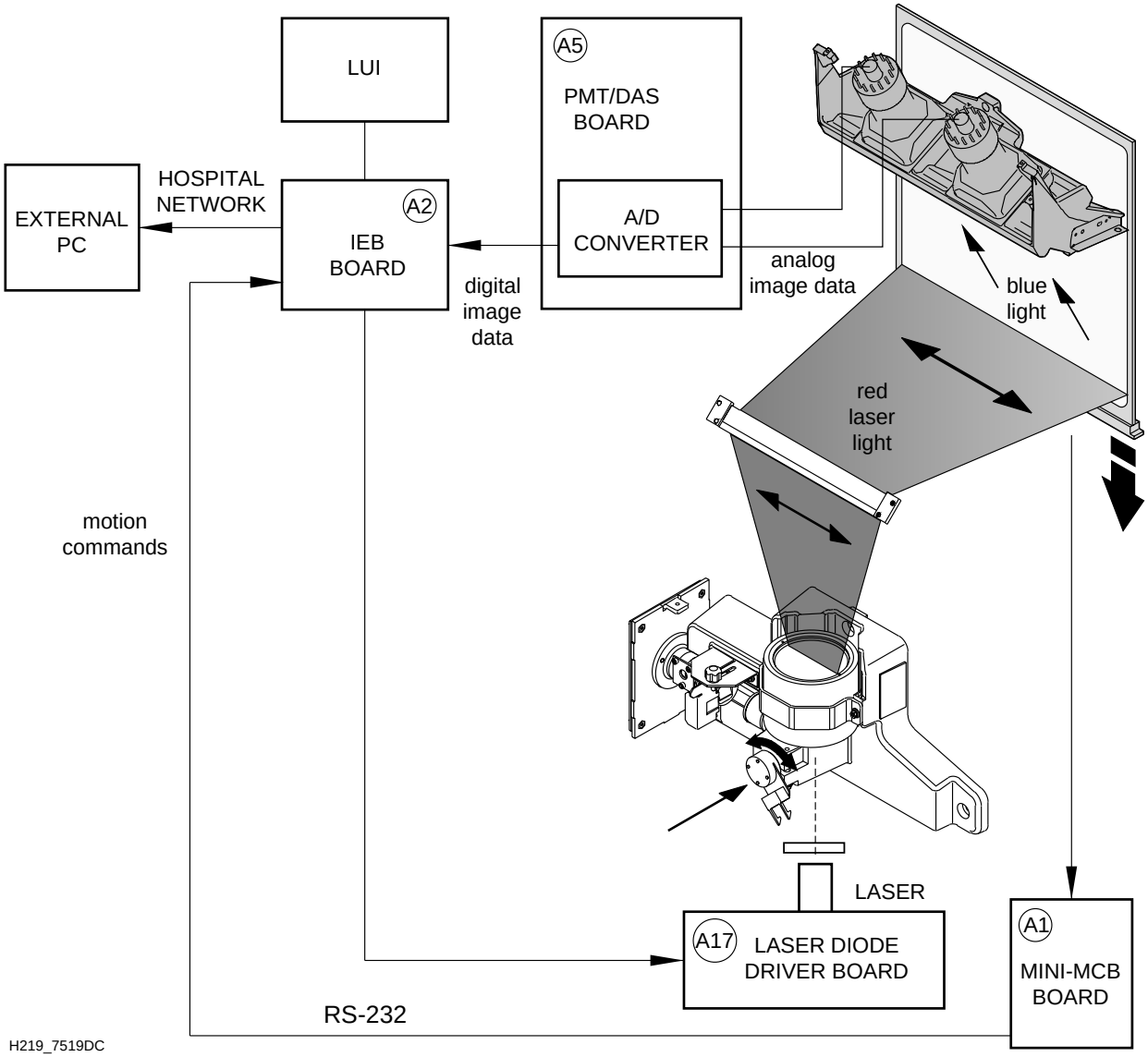
- The MINI-MCB BOARD A1 and the IEB BOARD A2 are not visible in the graphic.
- The length of time the ERASE LAMPS illuminate is determined by the highest pixel code value of the image that was scanned. If one pair of LAMPS is not operating, the time increases by a factor of 2. If more than one pair of LAMPS is not operating, a message displays on the MONITOR.

LAMP CURRENT SENSORS CS1 - CS5

Each pair of ERASE LAMPS has one BALLAST. A LAMP CURRENT SENSOR monitors the electrical current to each BALLAST.

Section 8: Imaging Sequence

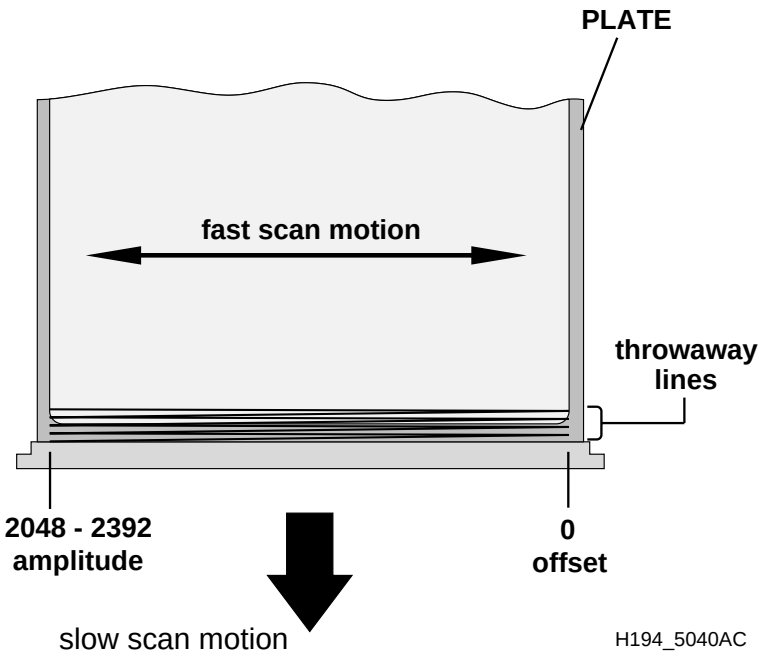
Overview



The CLASSIC/ELITE CR SYSTEM uses the components of the Optical and Scan/Erase subsystems to make the digital images. The imaging sequence includes:

- **Scanning the SCREEN - Slow Scan/Fast Scan**
- **Obtaining the Image Data**
- **Processing the Data**
- **Processing the Image**

Scanning the SCREEN - Slow Scan/Fast Scan



1 When the PLATE reaches the mechanical “Start Of Scan” position, the MINI-MCB BOARD A1 sends a message to the IEB BOARD A2 that the SCREEN is ready for scanning.

2 The IEB BOARD A2 sets up the GALVO SYSTEM and PMT/DAS BOARD A5 with the following information recorded during calibration of the CLASSIC/ELITE CR SYSTEM:

- offset and amplitude of the GALVO
- gain of the PMTs
- high voltage of the PMTs
- number of pixels/line
- number of lines to scan
- offset for start of fast scan

Note

The number of lines scanned includes the lines scanned for the image and also the “throwaway lines”. “Throwaway” lines at the beginning of the scanning are lines that are scanned but are not part of the image.

On GP and HR PLATES, the start and stop of the fast scan is approximately 10 pixels in from the edge of the PHOSPHOR. The actual distance will vary from approximately 1 mm for small CASSETTES to approximately 5 mm for larger CASSETTES, because the pixel size is smaller on the small CASSETTES. This START/STOP OFFSET is determined at the calibration of the CASSETTE.

EHR MAMMOGRAPHY and LLI CASSETTES perform an overscan which shows the edge of the SCREEN.

3 The IEB BOARD A2 sends messages to:

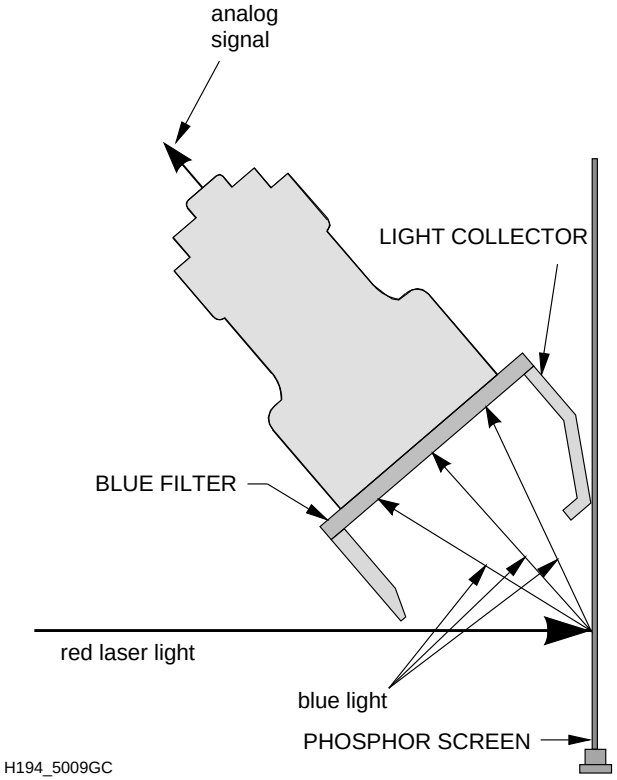
- MINI-MCB BOARD A1 to start the slow scan
- PMT/DAS BOARD A5 to start the collection of data
- start the GALVO MOTOR

4 The GALVO starts and provides the deflection of the laser beam onto the SCREEN. The laser beam moves horizontally across the SCREEN. This horizontal motion is the fast scan direction. See **GALVO**.

5 At the same time, the SCREEN moves vertically. This vertical motion is the slow scan direction.

Both motions are determined by calibration data for the given SCREEN size. The MINI-MCB BOARD A1 controls the slow scan motion. The IEB BOARD A2 controls the fast scan motion.

Obtaining the Image Data



1 The red laser beam scans across the PHOSPHOR SCREEN in the fast scan direction. When it hits the PHOSPHOR charged by the X-ray exposure, it causes the PHOSPHOR to emit blue light. The brightness of the blue light is proportional to the strength of the X-ray and the power of the LASER at the point it hits the PHOSPHOR. The light is emitted in a random pattern.

2 The collection of random blue light is provided by the COLLECTOR, which reflects the light toward the FACES of the 2 PMTs:

- for each line of the fast scan, a given number of measurements is made, determined in the IEB BOARD A2 by the size of the SCREEN. This is the “sampling rate.” The sampling rate defines the size of each pixel of information that is read from the SCREEN. For more information about sampling, see **Changing Analog Signals to Digital Signals**.
- both the red light from the LASER and the blue light emitted from the PHOSPHOR is emitted toward the COLLECTOR. A BLUE FILTER prevents the red light from entering the PMTs. The BLUE FILTER allows only the blue light into the PMTs.

3 The PMTs change the light energy into analog electrical current signals.

4 The output from each of the 2 PMTs is sent to the PMT/DAS BOARD A5. The PMT/DAS BOARD A5 changes and amplifies the output to a proportional voltage signal.

5 Gain control is applied to each of the voltage signals to correct for gain variations from the 2 PMTs.

6 The SUMMING AMPLIFIER adds the corrected signals and an offset adjustment signal is also added. This new signal is sent through a LOW PASS FILTER for noise reduction.

7 The voltage signal is sent through a 16-bit ANALOG-TO-DIGITAL (A/D) CONVERTER, which changes it to a 16-bit digital signal.

8 The 16-bit image data is sent in a serial-data stream to the FPGA in the IEB BOARD A2.

Processing the Data

1. The pixels are stored in a FIFO BUFFER in the FPGA on the IEB BOARD A2. The data is stored in the FIFO BUFFER in the FPGA until a complete line of data is received.
2. In rapid sequence, when the GALVO is moving to the start of the next line:
   - each line is moved to RAM on the IEB BOARD A2 using Direct Memory Access (DMA)
   - after the data is in the RAM, image processing starts
3. The GALVO begins to scan the next line on the SCREEN.
4. When the GALVO is scanning the next line, the IEB BOARD A2 processes the last line received. During this time, the IEB BOARD A2 applies the “Collector Profile” to each pixel to adjust for any change in the efficiency of the COLLECTOR.
5. The IEB BOARD A2 changes the pixels from 16-bit linear values to 12-bit log values. Each pixel has a value between 0 - 4095. The image is now a “raw image” that is formatted. The image is stored in a BUFFER on the IEB BOARD A2.

Note

When the bar code is read and the CASSETTE moves to the load position, the EXTERNAL PC sets up a raw image file to receive the raw image from the IEB BOARD A2. The size of the file is determined by the size of the SCREEN.

6. The IEB BOARD A2 sends the full raw image to the EXTERNAL PC line-by-line.
7. When the IEB BOARD A2 determines that the number of lines are scanned for the size of the SCREEN, the PLATE is sent to be erased.

Processing the Image

1 When the software on the EXTERNAL PC detects that a raw image was received from the IEB BOARD A2, the software:

- places the data in a prepared raw image file
- checks the CASSETTE ID
- locates the patient record that matches the CASSETTE ID

2 The software on the EXTERNAL PC:

- calculates the BLACK SURROUND MASK (BSM) used for making the areas outside the image black. The software automatically detects more than one exposure on any CASSETTE
- uses the body part and “projectile” information, and the image to determine the necessary processing parameters
- uses the processing parameters to calculate a digital density Look-up Table (LUT), and gain tables, and applies them to the image. The gain tables include:
  - “Tonescale”
  - sharpness
  - noise correction
- makes preview and thumbnail size images to display

Note

The full 6.5 - 60 MB raw image is stored on the HARD DRIVE of the CLASSIC/ELITE CR SYSTEM. The image viewer allows you to view the image at 100% size.

3 The operator touches or clicks the thumbnail image on the MONITOR. The operator makes changes and corrections to the subsample image and stores the changes. The software applies all the processing changes to the full resolution image and stores the changes in the database. The changes are applied to the image that is sent to any network nodes.

4 The internal CR SYSTEM software, called the Medical Image Manager (MIM) software, adds the Digital Imaging and Communication in Medicine (DICOM) information to the image file.

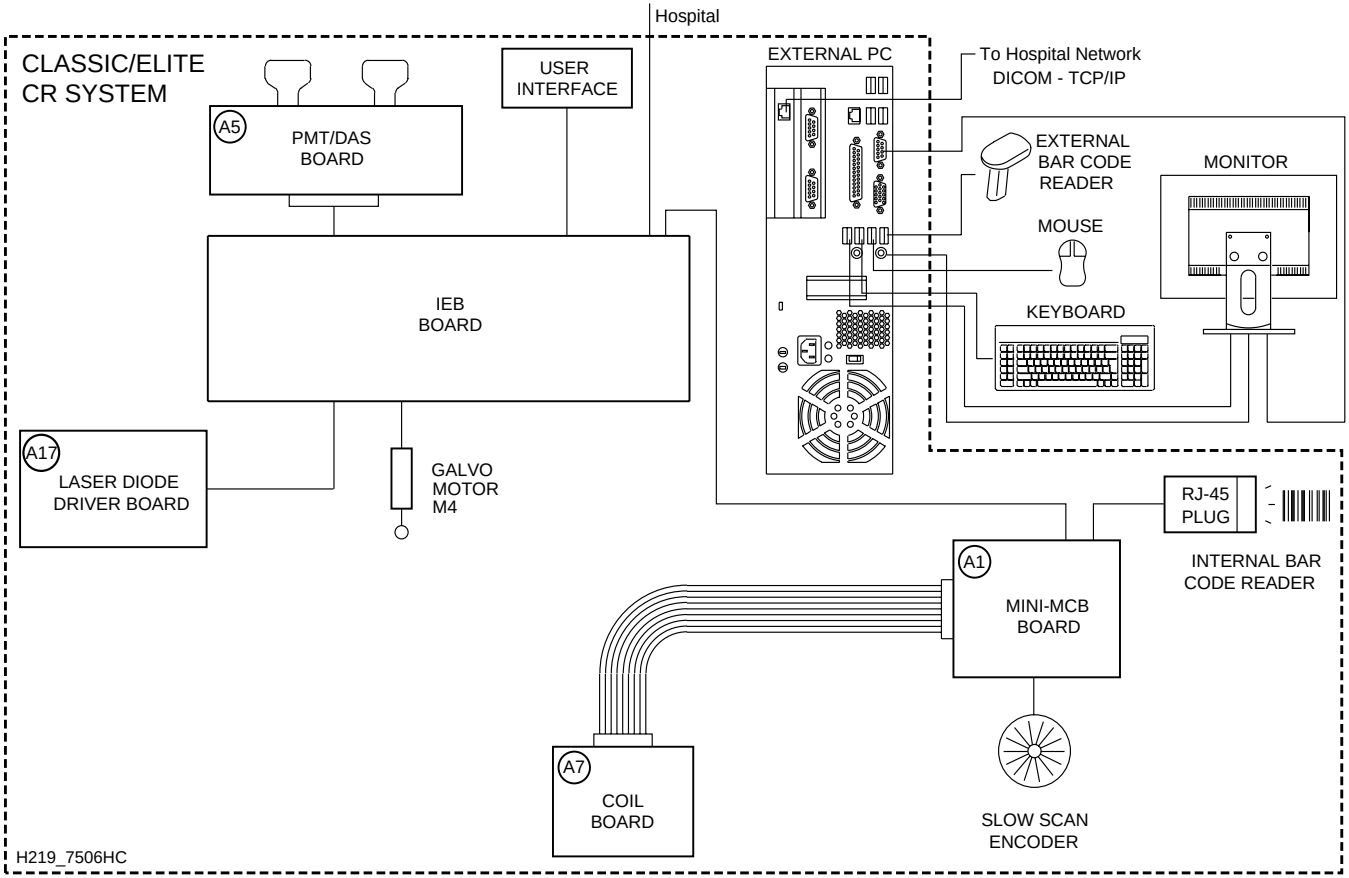
5 The MIM software makes a copy of the DICOM file and sends information from that file to all network nodes. The MIM software recognizes the features of each node and adjusts the image for correct viewing at each node.

Note

After the MIM sends the processed image, the DICOM file is deleted. The original raw image file and all the processing parameters are stored in a database directory of the EXTERNAL PC for possible use at another time. The database has a maximum storage level, after which a program automatically deletes the raw image, thumbnail files, and all associated information.

Section 9: Logic and Control

Overview



The Logic and Control subsystem:

- processes commands from the operator
- controls the operation of all subsystems
- sends processed images to the network for distribution

The Logic and Control subsystem includes:

- Operator Input Components
- BOARDS
- Distribution of Images to the Network

Operator Input Components

MONITOR

The MONITOR allows the operator to enter information for an exam into the CLASSIC/ELITE CR SYSTEM. The display of the MONITOR has a menu and control system.

The MONITOR for the ELITE CR SYSTEM is a TOUCH SCREEN. The standard MONITOR for the CLASSIC CR SYSTEM is not a TOUCH SCREEN, but the customer can purchase an optional TOUCH SCREEN.

The EXTERNAL PC provides the screen format for each menu item selected. The MONITOR enables the operator to select a displayed menu item or control by touching the SCREEN, or by moving and clicking the MOUSE. This action sends a command to the CLASSIC/ELITE CR SYSTEM. The EXTERNAL PC sends the necessary data to do that action. CONTROL BUTTONS on the MONITOR allow the user to select functions and to move to other menus or functions.

VIRTUAL KEYBOARDS for entering information into the CLASSIC/ELITE CR SYSTEM display on the MONITOR. The configuration of the KEYBOARD is determined by the type of information to be entered. Each KEYBOARD automatically displays when a menu item is selected to enter data.

The system also uses typed input from a PHYSICAL KEYBOARD connected to the EXTERNAL PC.

Main Menu

The main menu provides access to the controls for the operation and service of the CLASSIC/ELITE CR SYSTEM. The following table describes the menu items that are available to operators. Each type of operator has a password that allows access to the indicated menu items.

Under “Study Data”, you can:

- enter or retrieve patient information
- make a “Study” with a series of images

Under “Image Review”, you can:

- review images
- send images to a DESTINATION
- check for correct exposure of an image

Under “Key Operator Functions”, you can:

- set “Looks Preferences”
- set “Procedure Code Mapping”
- configure “Image Review Palettes”
- configure “Patient Input” screens

Operator Type	Can View Main Menu Items:	Description
Operator	• Study Data • Image Review	Operators can view patient data and images.
Key Operator	• Key Operator Functions • Study Data • Image Review	Key Operators can: • set up system and image processing default parameters • view patient data and images
Security Administrator	• Security Administrator • Key Operator Functions • Study Data • Image Review	Security Administrator can: • set up the MONITOR, SMPTE Test Pattern, and Diagnostic Image configuration • set up system and image processing default parameters • view patient data and images

Operator Type	Can View Main Menu Items:	Description
Service Provider	• Service Functions • Security Administrator • Key Operator Functions • Study Data • Image Review	Service Providers can: • have access to diagnostic and service menus, including: – diagnostics – configuration of formats for the bar code – configuration of the network • set up the MONITOR, SMPTE Test Pattern, and Diagnostic Image configuration • set up default system and image processing parameters • view patient data and images

LOCAL USER INTERFACE (LUI)

The LUI is a TOUCH SCREEN INTERFACE BOARD that provides a local interface to the CLASSIC/ELITE CR SYSTEM. The LUI provides access to Utility menus, service functions, and provides error and status display.

The LUI has a 100-BaseT connection with the IEB BOARD A2, and provides TCP/IP and FTP SERVER support.

The LUI is a QVGA (320 x 240 pixel) RGB TFT LCD with a TOUCH SCREEN. The LUI includes an audible device.

BOARDS

The BOARDS control the operation of the CASSETTE HANDLING, Optical, and Scan/Erase subsystems and the imaging sequence of the CLASSIC/ELITE CR SYSTEM.

BOARD	Description
MINI-MCB BOARD A1	Controls the electro-mechanical devices in the CLASSIC/ELITE CR SYSTEM, including: • motion of the CLAMP MOTOR • illumination of the ERASE LAMPS • motion of the HOOKS MOTOR The MINI-MCB BOARD A1 also: • controls the SLOW SCAN MOTOR that provides an interface to: – remove the PLATE from the CASSETTE before scanning and insert the PLATE back into the CASSETTE after scanning – control the slow scan motion of the PLATE during scanning – control the motion of the PLATE when it moves to and from the erase position • provides an interface for the INTERNAL BAR CODE READER • controls all vertical motion of the PLATE in a continual motion. This motion is at a right angle to the direction of the horizontal fast scan motion of the LASER. • connects to the COIL BOARD A7 in the SLOW SCAN MOTOR to drive the COILS and read the HALL EFFECT SENSORS • connects to the ENCODER at the bottom of the SLOW SCAN MOTOR ASSEMBLY

BOARD	Description
IEB BOARD A2	The BOOT CODE of the IEB BOARD A2: • provides configuration information for the MICRO CONTROLLER • starts the application program for the CLASSIC/ELITE CR SYSTEM • checks that signals can be sent to the EXTERNAL PC The IEB BOARD A2: • obtains raw image data • changes the image data from 16-bit linear to 12-bit log data • actuates the LASER • provides correction of the “Collector Profile” for the image data • sends the image to the EXTERNAL PC for image processing and viewing • provides the scanning parameters determined by the size of the SCREEN to be scanned • records the maximum pixel value of a scan to allow the “smart erase” algorithm to calculate the time to erase the SCREEN • provides an interface to the MINI-MCB BOARD A1

BOARD	Description
IEB BOARD A2 (continued)	• The FPGA on the IEB BOARD A2: – controls the SPI to the PMT/DAS BOARD A5 – obtains the image data from the PMT/DAS BOARD A5 and sets up timing and control to the PMT/DAS BOARD A5 and the GALVO – synchronizes the start and horizontal motion of the GALVO fast scan and the PMT/DAS A/D CONVERTERS that obtain the data – receives image data one pixel at a time from the PMT/DAS BOARD A5 and stores the data in a FIFO BUFFER until a line is completed. One pixel is made of 16-bit segments. – starts DMA transfer of the image data from the FIFO BUFFER to the FPGA when each line is completed • The IEB BOARD A2: – provides drive and feedback signals to control the position of the GALVO MIRROR that provides the deflection of the laser beam onto the SCREEN during the fast scan operation – sends data to the GALVO CONTROL, then sends timing signals to command the GALVO to move the MIRROR through a full line cycle – provides timing and control of the LASER DIODE DRIVER BOARD A17 • At the end of the cycle, the GALVO CONTROL sends a signal to the IEB BOARD A2 to indicate that the line is completed. • A closed loop SERVO CIRCUIT uses the POSITION SENSORS in the GALVO to keep the speed of the MIRROR smooth and in the position necessary for the maintenance of image quality.

BOARD	Description
PHOTOMULTIPLIER TUBE/ DATA AQUISITION SYSTEM (PMT/DAS) - A5	Amplifies, adds, and filters the data from the 2 PMTs, then changes the analog data to digital data. The PMT/DAS BOARD A5 also supplies power to the 2 PMTs.
COIL - A7	Includes 6 triangular-shaped WIRE COILS around the CENTRAL SHAFT of the SLOW SCAN MOTOR. At the outside edge of the COILS are 3 HALL EFFECT SENSORS. These components work with the SLOW SCAN CONTROLLER and the MAGNET of the SLOW SCAN MOTOR to rotate the MOTOR.
LASER DIODE DRIVER - A17	Includes a LASER DIODE that provides the red laser light used to scan the SCREEN. The IEB BOARD A2 controls the operation of the LASER DIODE DRIVER BOARD A17.
LOCAL USER INTERFACE (LUI) BOARD	The LUI: • provides a local interface to the system • allows the operator to view messages

Distribution of Images to the Network

Overview

The EXTERNAL PC receives raw images from the IEB BOARD A2, processes the images, and stores or sends the images to given nodes in the hospital network. *Ethernet* CABLES connect both the IEB BOARD A2 and the EXTERNAL PC to the hospital network.

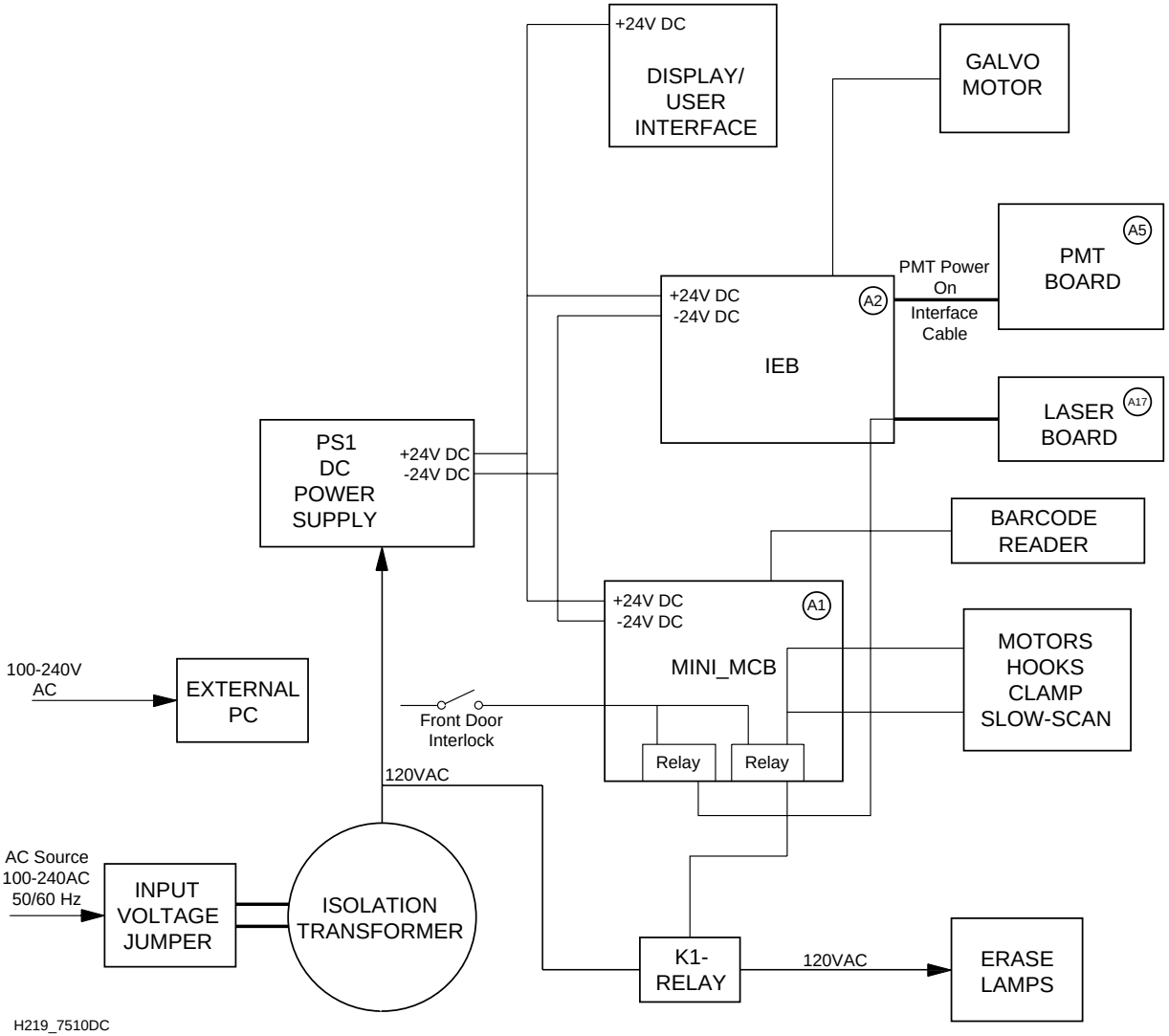
Sequence of Operation

1. When the CLASSIC/ELITE CR SYSTEM has made a raw image, a new folder is created in the DATABASE of the EXTERNAL PC for the image and associated other files. The name of the new folder is “C:\inetpub\wwwroot\images\<DB guid>_<custom extension>”.
2. The “RawImageProcessing Service” creates the following files in the folder:
   - “<XXX>.raw” - the raw image is named by the acquisition service
   - “Catalog.xml” - a list of the files stored in the folder
   - “State.xml” - internal image processing information
   - “Thumbnail.163.200.raw” - the thumbnail image. The width and height of the thumbnail are indicated in the name of the file.
   - “Processed.2048.2500.raw” - full size image. The width and height of the full size image are indicated in the name of the file.
   - “Preview.901.1100.raw” - preview image. The width and height of the preview are indicated in the name of the file.
   - “Exposure.0.unprocessed.2048.2500.raw” - raw, full size field image
   - “Exposure.0.subsample.227.277.raw” - raw, sub-sampled exposure field data
   - “Exposure.0.digital.4096.UInt16” - the LUT generated during “Eclipse” processing
   - “Exposure.0.anatomy.227.277.mask” - raw, sub-sampled anatomy MASK for the exposure field
   - “Display.4096.UIint16” - LUT to change GSDF output for display
3. Any event can cause an image review to occur:
   - “Pass-Thru Mode” - the image is advanced with no review
   - “QA Mode” - image review is necessary, and the user must click [Accept]

4. Temporary files for the MIM are created in a new folder with the name “C:\Program Files\KodakCaptureConsole\bin\MIM Core\Images\<id>”:
   - “<id>_processed.tif” - 12-BIT “.tif” image file
   - “<id>_dam.xml” - job setup - print, store, page layout, etc.
   - “<id>_clinical.xml” - all the DICOM TAGS to be put in the output DICOM file
5. The MIM controls all the DICOM communication.

Section 10: Power Distribution

Overview



The Power Distribution subsystem includes:

- POWER SUPPLY
- Power Distribution
- INTERLOCK
- TRANSFORMER T1

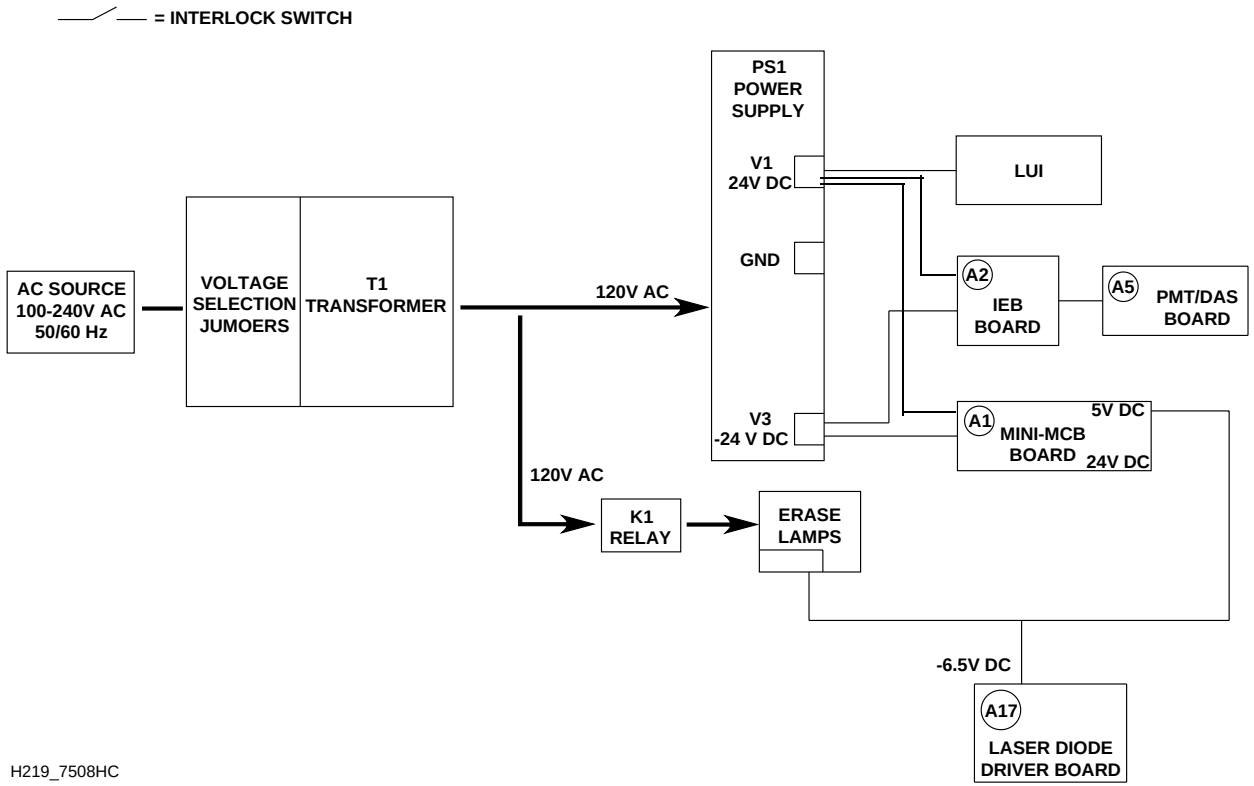
POWER SUPPLY

The CLASSIC/ELITE CR SYSTEM operates correctly when connected to the power sources described in the table below. These voltages can be obtained from a line-and-neutral or line-to-line connection. For all voltages, only a single-phase power distribution system is necessary.

The input power is changed at the TRANSFORMER T1 to an output voltage of 120 V AC. No additional FILTERS, TRANSFORMERS, or other devices are necessary to provide correct operating voltage. When installing the CLASSIC/ELITE CR SYSTEM, you must set the VOLTAGE SELECTION JUMPER for the voltage at the site.

Voltage	Tolerance	Current	Frequency	VOLTAGE SELECTION JUMPER
100 V AC	±10%	10 A	50/60 Hz	100 V
110 VAC	±10%	10 A	50/60 Hz	120 V
115 V AC	±10%	10 A	50/60 Hz	
120 V AC	+10%, -13%	10 A	50/60 Hz	
127 V AC	±10%	10 A	50/60 Hz	
200 V AC	±10%	5 A	50/60 Hz	200/208 V
208 V AC	±10%	5 A	50/60 Hz	
220 V AC	±10%	5 A	50/60 Hz	230 V
230 V AC	±10%	5 A	50/60 Hz	
240 V AC	+6%, -10%	5 A	50/60 Hz	

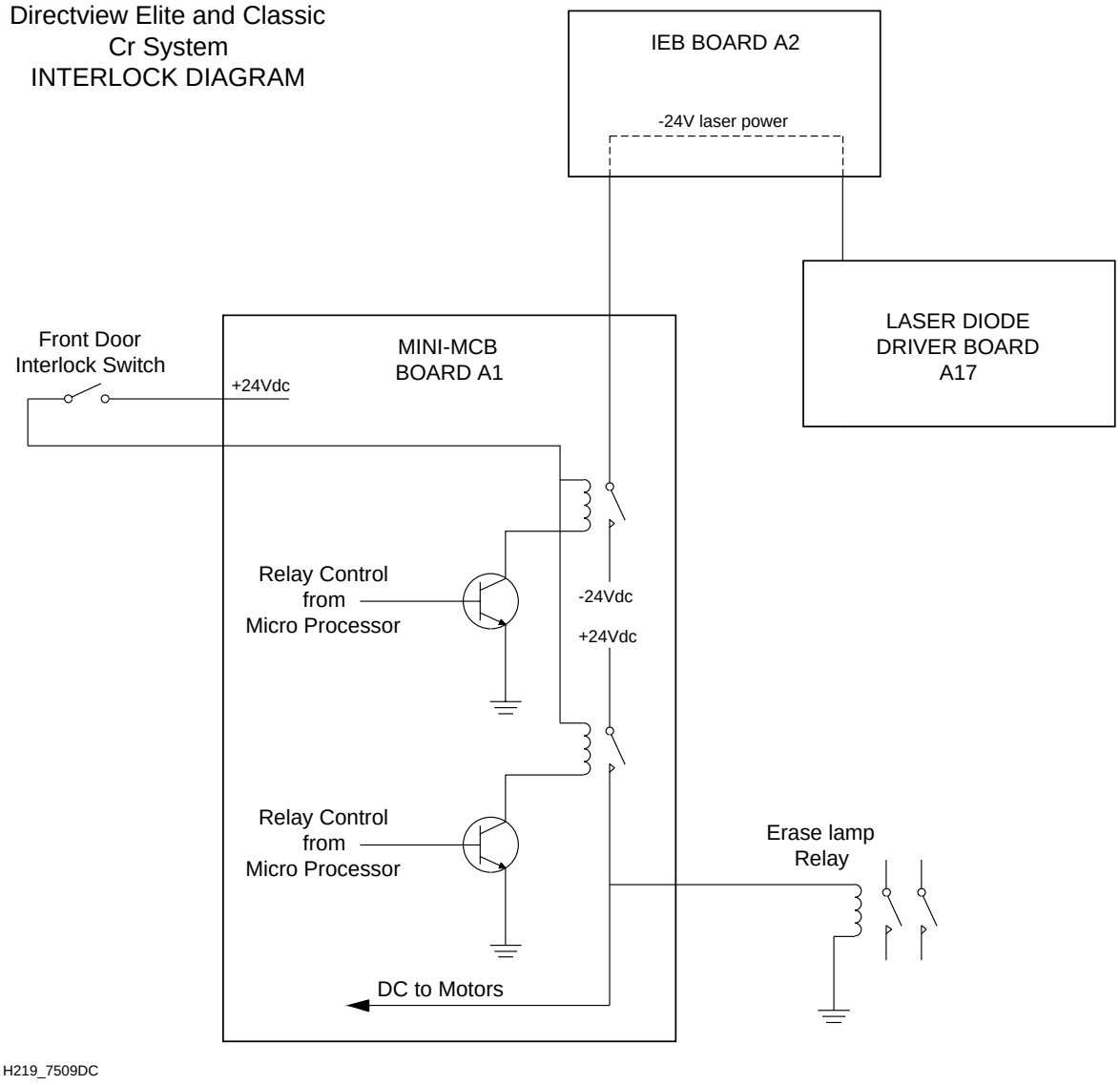
Power Distribution



Supply	Description
INTERLOCK SWITCH	The INTERLOCK SWITCH controls RELAYS on the MINI-MCB BOARD A1, which controls the 24 V DC power to the DC components, including the MOTORS and LASER. The INTERLOCK SWITCH deactuates when the FRONT DOOR is opened.
ISOLATION TRANSFORMER T1	The TRANSFORMER T1 receives from 100 to 240 V AC, 50/60 Hz, and changes this power to 120 V AC, 50/60 Hz. You must set a VOLTAGE SELECTION JUMPER to match the voltage at the site.

Supply	Description
DC POWER SUPPLY PS1	This DC POWER SUPPLY has +/-24 V DC outputs only. It receives 120 V AC and supplies all the BOARDS. The ERASE ASSEMBLY does not receive power from the POWER SUPPLY PS1.
ERASE LAMP RELAY K1	Provides 120 V AC to the ERASE LAMPS.

INTERLOCK



The INTERLOCK protects users from exposure to electrical systems by de-energizing selected systems when the FRONT DOOR opens.

The FRONT DOOR INTERLOCK SWITCH controls RELAYS on the MINI-MCB BOARD A1 that de-energizes the following systems:

Systems Protected by INTERLOCK SWITCH	Description
MINI-MCB BOARD A1	• has an LED that indicates the status of the INTERLOCK SWITCH DS4 • controls the INTERLOCK SWITCH for all DC MOTORS
LASER DIODE DRIVER BOARD A17	6.5 V. DC from the IEB BOARD A2 is de-energized when the INTERLOCK SWITCH is opened.
ERASE LAMPS	120 V AC is de-energized when the INTERLOCK SWITCH is opened.

TRANSFORMER T1

The TRANSFORMER T1 receives from 100 to 240 V AC, 50/60 Hz, and changes this power to 120 V AC, 50/60 Hz. You must set a VOLTAGE SELECTION JUMPER to match the voltage at the site.

Section 11: Logs

Overview

The IEB BOARD A2 receives log information from components in the CLASSIC/ELITE CR SYSTEM and sends the information to the EXTERNAL PC for display on the MONITOR.

The CLASSIC/ELITE CR SYSTEM provides the following logs:

- **Error and Activity Log**
- **Actuation Log**

All logs:

- include the date and time
- are in English
- can be viewed:
  - by service personnel
  - on the CLASSIC/ELITE CR SYSTEM or from a remote network node

Error and Activity Log

The Error and Activity Log provides information for 2 types of errors:

- errors the operator can correct:
  - messages and error codes display on the MONITOR
  - a message displays on the MONITOR if important data might be changed or deleted
  - messages provide instructions that the user must do before starting operation of the CLASSIC/ELITE CR SYSTEM again
  - logs of error codes and messages are stored on the HARD DRIVE of the EXTERNAL PC
- errors the operator cannot correct:
  - messages and error codes display on the MONITOR
  - logs of error codes and messages are stored on the HARD DRIVE of the EXTERNAL PC
  - the action of a Service Provider might be necessary to clear the error

The Error and Activity Log also provides information on actions within the CLASSIC/ELITE CR SYSTEM that are not errors. For example, when the DOOR is opened, a log entry is made.

The Error and Activity Log includes the following information:

- date and time the error or actions were detected
- error code
- CASSETTE ID
- error message

Actuation Log

The Actuation Log records all the times the system is actuated. This log is available to Key Operator Personnel. Entries in the Actuation Log can be sorted by CASSETTE ID, date, time, and technician ID.

Information included in the Actuation Log:

- number of all actuations
- number of images deleted before transmission, including:
  - technician ID
  - exam type
  - CASSETTE ID
- number of successful image transmissions to all network nodes, including:
  - time and date of the successful transmission
  - image ID
  - network node ID

Section 12: Glossary

Term	Description
A/D	Analog-to-digital.
Amplitude	Position of the GALVO when the laser beam has reached the end of the trace across the PHOSPHOR PLATE in the fast scan direction, determined by the size of the PLATE.
Artifact	Any irregularity on the radiograph caused by lint, dust, electrostatic discharge, processing, storing, or handling that is not correct.
Aspect ratio	Measurement of an object in the fast scan and slow scan directions. For example, if a square object were exposed and the image processed, the processed image should remain square, not rectangular in shape.
Backscatter	Radiation that is scattered backward in the path of the original beam. *Kodak DirectView* CR CASSETTES have a backscatter-control layer to decrease backscatter.
Bar Code	A series of vertical BARS on a label that provide information that can be read by a computer. The BAR CODE LABEL on a CASSETTE for the CLASSIC/ELITE CR SYSTEM uses a 10-digit code to identify the size, resolution, and serial number of the CASSETTE.
BAR CODE READER	Device for reading BAR CODE LABELS.
CLUSTER	A collection of CR SYSTEMS and the *Kodak DirectView* REMOTE OPERATIONS PANEL (ROP) that can exchange patient exam and image information on a network.
CR	Computed Radiography.
DICOM	Digital Imaging and Communication in Medicine. Standard for transferring medical images on a network.
DIS	DICOM Information System. An information system or front end to an information system that can operate with DICOM HIS/RIS services.
DMA	Direct Memory Access.

Term	Description
EVP	Enhanced Visual Processing. An algorithm for improving contrast included in the IPL.
Exam	A collection including a raw image, versions of the image, exam information, and patient information.
Exam information	Data that describes an exam procedure.
Exam type	Body part and projection. Body position is optional data.
FIFO BUFFER	FIRST IN, FIRST OUT BUFFER. The CLASSIC/ELITE CR SYSTEM uses a FIFO BUFFER to receive pixel data from the PMT/DAS BOARD A5, assemble it into a line of data, and send it to the IEB BOARD A2.
Flat field exposure	PLATE exposed from 10 mR to 30 mR for calibration.
Gain	The increase in signal when transferred from one point to another.
GP CASSETTE	General Purpose CASSETTE.
HIS/RIS	Hospital Information System/Radiology Information System. HIS/RIS indicates that both systems are at the same site, but does not indicate that the systems are connected or are part of the same network.
HR CASSETTE	High Resolution CASSETTE. The layer of PHOSPHOR on the SCREEN is thinner than on a GP CASSETTE. The thinner layer allows the HR CASSETTE to capture more information than a GP CASSETTE.
Image	Data in a DICOM-compliant format, which includes image data, patient information, and information about the procedure for capturing the image data.
INTERLOCK SWITCH	De-energizes all dangerous systems if the DOOR for user access is open.
IPL	Image Processing Library. The image processing algorithms used by the CLASSIC/ELITE CR SYSTEM.
kV	Kilovolts. A measurement of the strength of an X-ray beam.
kVp	Kilovolts peak.

Term	Description
LUT	Look-Up table. A matrix which changes image values from one type of measurement into another; for example, density to luminance.
Mandatory destination	A network node to which all images from the CLASSIC/ELITE CR SYSTEMS are sent.
mA	Milliamperes. The measurement for the quantity of X-ray energy emitted in a given time.
MIM	Medical Image Manager.
mR	1/1000 of a Roentgen. Measure of exposure energy at the detection device.
NVRAM	Non-Volatile Random Access Memory. A read/write memory that receives power from a BATTERY when necessary.
Offset	Position of the GALVO when the laser beam first reaches the edge of the SCREEN. In the fast scan direction, the offset is the “0” position.
Patient information	The data about a patient.
PCMCIA	Personal Computer Memory Card International Association.
PCMCIA CARD	A memory card that includes the calibration data and the “Collector Profile”.
PEC record	The information describing the patient, exam, and the CASSETTE used for the exam. The PEC record identifies a given image.
Photostimulable luminescence	A condition in which PHOSPHOR discharges stored energy when stimulated by infrared or visible light.
Pixel code value	The value of each pixel of information that includes both the measurement for samplings in the fast scan direction and the lines in the slow scan direction.
Radiographic Technologist	A person that provides diagnostic levels of radiation to make diagnostic images.
RAP	REMOTE ACCESS POINT
Resolution	Ability of an imaging system to detect separate lines that are close together.

Term	Description
Retrace	Motion of the laser beam across the SCREEN after it has scanned a line.
ROP	REMOTE OPERATIONS PANEL.
RPDES	REMOTE PATIENT DATA ENTRY STATION
Routing	Transferring an image from a CLASSIC/ELITE CR SYSTEM to a given node on the network.
RS-232	Serial communication protocol.
SENSOR	A slotted OPTICAL SENSOR used to detect the motion of a component or an obstruction.
Spatial resolution	The measurement of the line pairs (LP)/mm. Spatial resolution is determined by system factors including scatter of the PHOSPHOR, spot size and shape of the LASER, and electronics bandwidth.
SRAM	Static Random Access Memory. SRAM keeps data bits continually in memory in a computer during the time power is provided.
STORAGE PHOSPHOR	PHOSPHOR that can store energy.
SVGA	SUPER VIDEO GRAPHICS ADAPTER. A video system name used on computers to describe the abilities of the graphic display.
TCP/IP	Transmission Control Protocol/Interchange Protocol.
TIMED PROGRESS BAR	A graphic display that indicates the status of the scanning operation. This is not a real-time indication.
Tone scale	A graduated range of gray values that improve an image for clinical diagnosis by highlighting the body parts that are necessary for the radiologist or physician to see.
Trace	Motion of the laser beam across the SCREEN in the fast scan direction.
Unassigned image	An image that is scanned and not matched to a PEC record at this time.
Unassociated image	An image that cannot be matched to an existing PEC record.

Term	Description
Unsharp masking	An algorithm for improving edges that provides a more defined image. When an original image is made that is not clear, the Unsharp masking procedure produces an image that is amplified.
Viewing station	DICOM viewing station - “World-Wide Workstation”.

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